Sky and TELESCOPE

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MAN'S FARTHEST STEP INTO SPACE

The last milestone before flight into interplanetary space was passed successfully on October 12, 1958, when the lunar probe Pioneer traveled to nearly 80,000 miles from earth, one-third of the distance to the moon. When the instrument package separated from the third-stage rocket, it was traveling some 34,400 feet per second, only 850 feet per second too slowly to attain the orbit planned.

This velocity is nearly that of escape from the earth. The narrowness of the margin is the true significance of the Pioneer rocket flight, for here is proof that space-flight is possible with existing multistage rockets, if all their complex components can be made to function together.

In this particular flight, the operations of the parts of the orientation system were not perfectly combined to achieve the delicate balance of speed and direction necessary for the precise orbit desired for the lunar probe. The direction of flight of the first-stage rocket was controlled by gyros, but these had a slightly higher drift rate than expected, with the result that the trajectory was some 3½ degrees too high. This, in turn, meant that the drag by gravity was greater and the vehicle was slowed down. It is believed that most, if not all, of the 850-feet-per-second loss in speed can be accounted for by the difference of 3½ degrees in the trajectory.

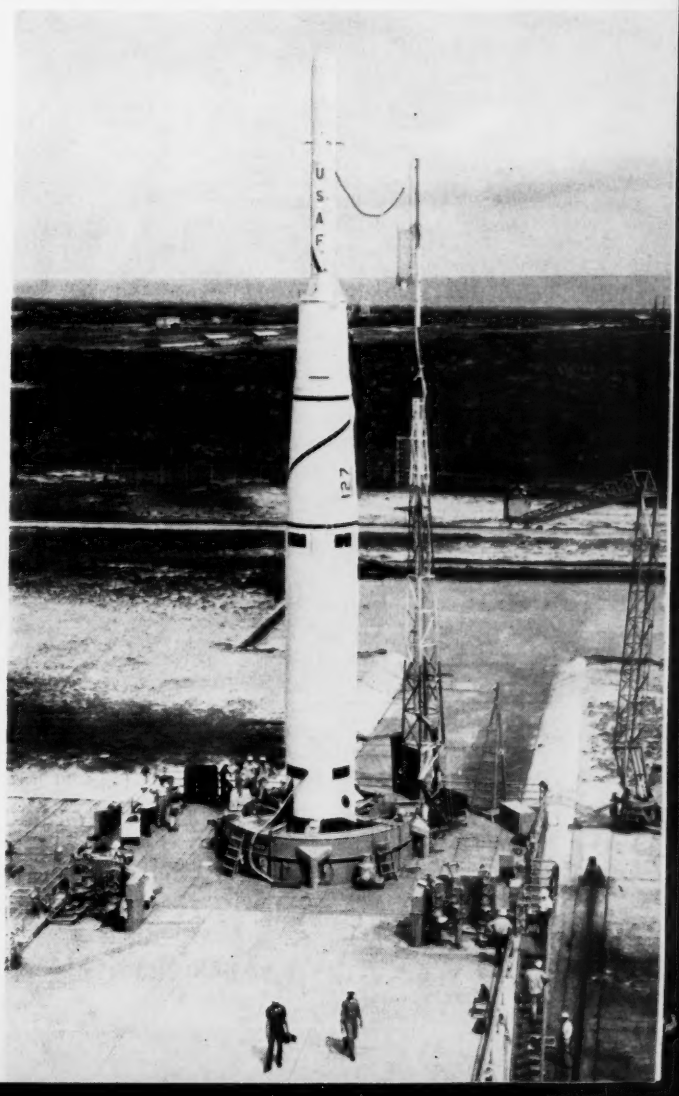
Yet this small difference so reduced the size of the missile's orbit that it attained its apogee point less than a day after launching, whereas its flight to the moon's orbit was expected to require more than 2½ days. The perigee point of the actual Pioneer orbit lay inside the earth, and after some 43 hours of flight it plunged back into the earth's atmosphere, to be destroyed like a meteor. It is believed to have fallen over the South Pacific Ocean.

Thus, this now-historical example demonstrates how critically the size of the orbit followed by a missile cast into space depends on its speed compared with the velocity of escape from the earth. The latter is about 36,700 feet per second at the earth's surface and decreases as the square root of the distance from the earth's center. At the moon's average distance (60 earth radii), the escape velocity is about 4,700 feet per second, while at the distance of 80,000 miles attained by Pioneer it is some 8,200 feet per second.

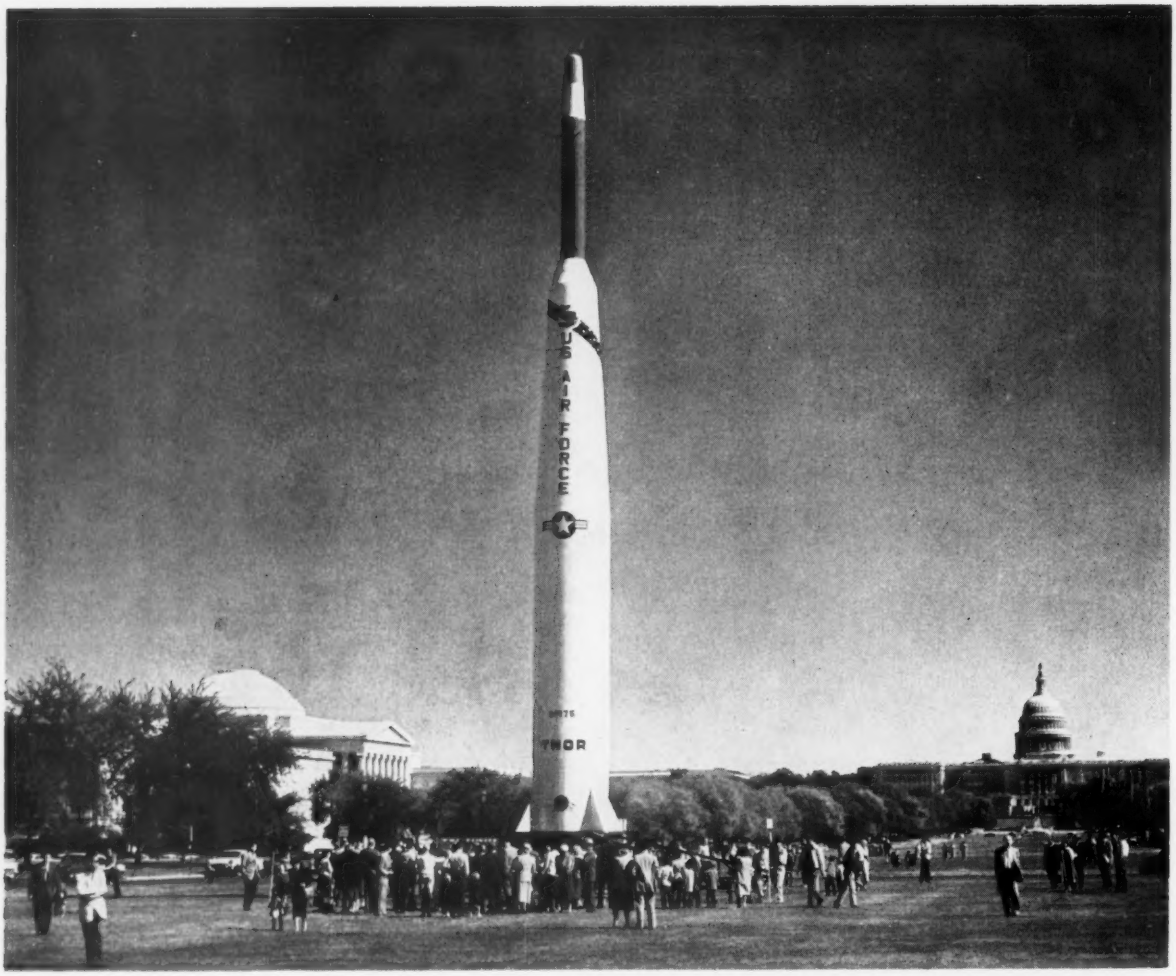
A missile moving more slowly than escape velocity will travel in a closed path — a circle or an ellipse — around the earth's center. Should the perigee distance happen to be less than the earth's radius, the orbit would come within the earth itself, and the body would collide with the surface.

If we consider higher and higher missile speeds — still always less than the velocity of escape — the corresponding orbits are ellipses of greater and greater size. In the following examples, air resistance and similar complications are neglected:

A rocket launched from the surface of the earth at



Amid a flurry of last-minute preparations for takeoff, the Pioneer vehicle, No. 127, rests on its launching pad at the Atlantic Missile Test Range, Cape Canaveral, Florida. Its first three stages are an Air Force Thor intermediate-range ballistic missile, a Navy Vanguard rocket modified for the purpose, and a Navy specially developed solid-propellant rocket. The vehicle was designed to deliver a payload of 83.8 pounds to the vicinity of the moon, and this payload package constituted a fourth stage. In the distance is seen the Atlantic Ocean, over which the rocket's trajectory arched soon after takeoff. U. S. Air Force photograph.



Among people of all ages in Washington, D. C., interest in their government's spaceflight projects is very high. On Saturday, October 11th, as soon as the Pioneer lunar probe was launched, the Air Force erected this full-scale model, about 90 feet tall, on the Mall midway between the Capitol and the Washington Monument. In this view of the Columbus Day crowd of sightseers the Capitol is seen at the right and the National Gallery of Art at the left. Sky and Telescope *photograph.*

0.9 times escape velocity will move in an elliptical orbit whose longest axis is 5.26 earth radii (about 21,000 miles). But for 0.99, 0.999, and 0.9999 times escape velocity, the long axis of the orbit is 50, 500, and 5,000 earth radii, respectively. If the initial velocity were exactly that of escape, the body would travel outward on an open, parabolic orbit of infinite size, never to return. At still higher launching velocities, the trajectory would be a hyperbola, also of infinite size. The significant point, in relation to Pioneer, is how very sensitive the apogee distance is to initial velocity.

Pioneer Research Program

The exciting range of astronomical observations and experiments that will become possible when rockets can circle the moon or land on it has already been surveyed on page 333 of the May issue. Two specifically lunar observations were intended for Pioneer.

One was the measurement of the moon's magnetic field, whose intensity is entirely a matter of conjecture at present. The other project was to scan the moon's surface with an infrared-sensitive television device, from whose telemetered signals a crude map of the invisible side of the moon could be constructed.

For this observation, the far side of the moon should be facing the sun, and this was the case when Pioneer was launched, as the lunar phase in mid-October was just past new. While there is no obvious reason for expecting that the averted face of the moon differs significantly from the visible one, the possibility of some novel finding on the nearly six million square miles of wholly unexplored lunar surface has a strong appeal.

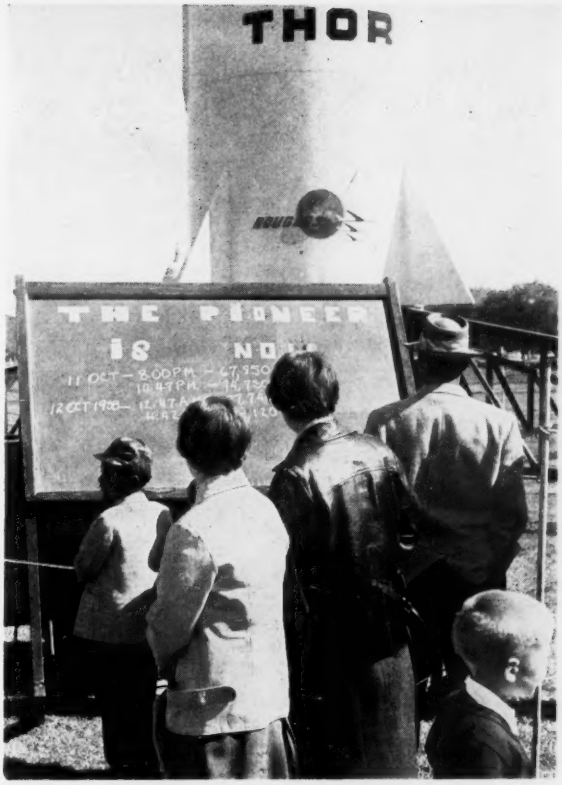
Additional experiments for the October flight were extensions of those already carried out by artificial satellites, but at much greater distances from the earth than ever before. The instrument package of Pioneer carried gauges for recording the impacts of micrometeorites. However, the telemetered counts were so few as to suggest that this part of the equipment did not function properly.

The missile's radio reported the change of temperature

of the interior of the instrument package. This was 71° Fahrenheit at launching, but dropped gradually until it became stabilized at about 35°. The intended temperature was 50° to 60°, and apparently this difference affected the batteries inside the case, frustrating the attempts to fire the last-stage retro-rocket by radio command.

During its 80,000-mile ascent, Pioneer gathered important new data on the high layer of intense radiation discovered earlier this year by the Explorer satellites (see *Sky and Telescope,* June, 1958, page 398). The radiation level indicated by the satellite observations, about two roentgens per hour at elevations around 2,000 miles, seems very hazardous to manned spaceflight. (The maximum safe level permitted for workers in atomic-energy industries is 0.3 roentgen per week.)

Preliminary analysis of the telemetered records of Pioneer suggests that the level of intensity rises to four roentgens per hour at 5,000 miles and then decreases, becoming three at 10,000 miles, and two at 17,000 miles above the earth's surface. Further observations of this kind are needed.



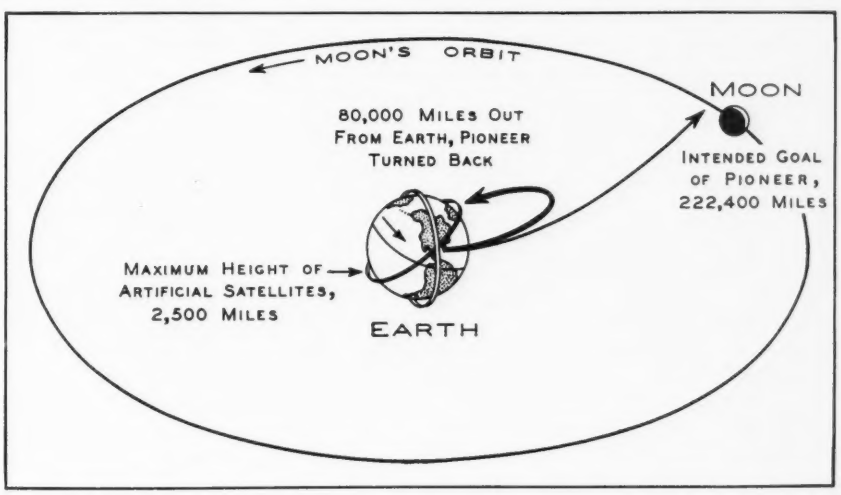
A closeup of the base of the Pioneer model that was set up on the Mall in Washington, D. C. Here the blackboard is seen on which the progress of the actual Pioneer during Sunday, October 12th, was posted, for the benefit of the eager onlookers. Sky and Telescope *photograph.*

Lunar Probe Launching Times

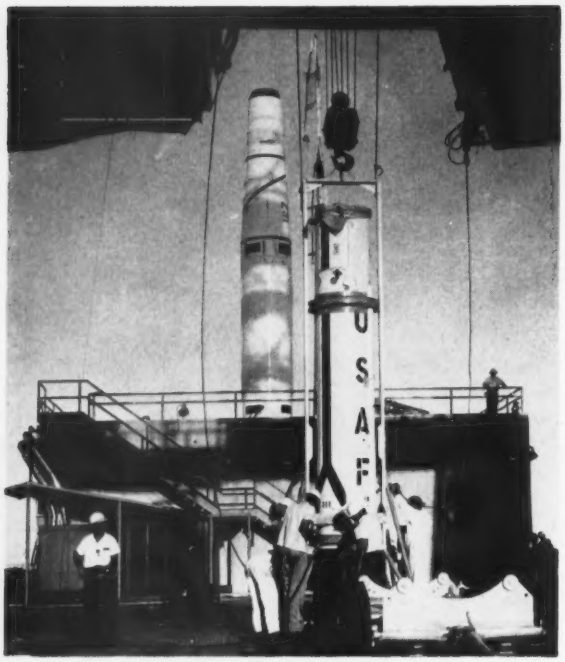
Sometimes it is supposed that the phase and distance of the moon are the primary factors in determining when to launch a rocket to the moon. Although the phase depends on the relative positions of the earth, moon, and sun, it is only a secondary consideration, since the gravitational effects of the earth and moon predominate along the path to be taken by the missile. The sun's influence may be readily compensated for in planning the trajectory. The exact distance of the moon at the time of interception is important principally in the timing of events in the vehicle's flight plan.

The factors that decisively affect the time of launching were discussed on page 625 of the October issue of *Sky and Telescope,* where it was shown that a favorable situation at Cape Canaveral occurs when the moon is crossing the earth's equatorial plane in a southward direction, and continues for about three days thereafter. A narrow limit on the time of day best for launching is set by the orientation required for the retro-rocket, and by the desire to utilize at least part of the earth's rotational speed (910 miles per hour eastward at Cape Canaveral).

On August 17th, the launching of a lunar vehicle was attempted, but it exploded 77 seconds after takeoff. This was about an hour before moonrise at Cape Canaveral, the local hour angle of the moon being 106.7 degrees east of the meridian. Therefore, in the October article


MOON'S ORBIT
MOON
80,000 MILES OUT FROM EARTH, PIONEER TURNED BACK
INTENDED GOAL OF PIONEER, 222,400 MILES
MAXIMUM HEIGHT OF ARTIFICIAL SATELLITES, 2,500 MILES
EARTH

Artificial satellite orbits are seen to be very near the earth compared with the orbit of the moon and the path of the first Pioneer. Even previous rocket flights to the highest altitudes, some 4,000 miles above the earth's surface, went out only one-tenth as far from the earth's center. In this sketch, perspective reveals some of the sunlit side of the moon, but it was at the new phase on October 12th, so only its dark side was facing the earth.



The second stage, consisting of a modified Vanguard rocket, is suspended on cables just before being hoisted into position to be joined to the Thor first stage. In the right foreground is the trailer used to haul the second stage to the launching pad. U. S. Air Force photographs.

it was predicted that another moon shot might be made on October 11th at about 9:00 UT, when the moon would have the same hour angle. The actual firing of the Pioneer vehicle took place at 8:42 UT. Of course, such a prediction assumed that the same rocket configuration was to be used.

It is evident that attempts to keep the launching times of projected lunar rockets from the public are useless, as it is an easy matter to foretell them, once the time of any one attempt is known for a particular rocket complex. Some favorable occasions during the next two months for a third lunar probe shot by the U. S. Air Force, if the design remains unchanged, are:

Date	*Universal Time*	*Moon's Declination*
November 7	6:27	+1° 49′
8	7:20	−3° 01′
9	8:15	−7° 46′
December 4	4:20	+3° 33′
5	5:10	−0° 53′
6	6:02	−5° 32′
7	6:57	−9° 58′

The U. S. Air Force has recently been granted authority for two more lunar probes, in addition to the three originally allotted to it last spring. (Two of these three have already been fired, on August 17th and October 11th.) The additional launchings will be attempted after the first of the year, according to press reports, which also suggest that one of the vehicles may be sent to the vicinity of Venus.

MARSHALL MELIN

The Launching of Pioneer

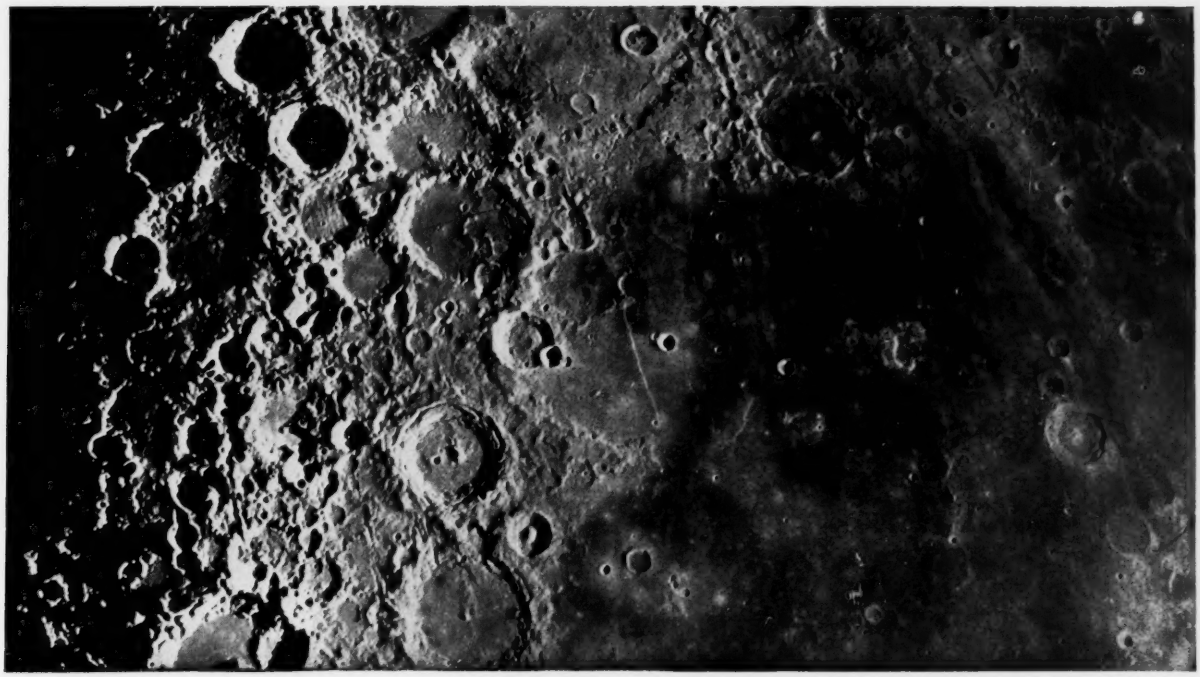
Design considerations impose severe limitations upon rockets used in experiments like the lunar probe. Since the frame must be as light as possible, it cannot be constructed to withstand much lateral force. This is the reason for the nearly vertical flight path until much of the denser atmosphere is left behind. Thereafter, the rocket is maneuvered into a sweeping turn in which its length becomes nearly parallel to the earth's surface.

The thrust, then applied in a nearly horizontal direction, works only against the inertia of the vehicle, and not against the earth's gravitational field, thus imparting a greater velocity to the rocket. In the case of Pioneer, drift of directional gyros in the first stage resulted in an ascent trajectory that was too steep by 3½ degrees, causing an insufficient velocity after the later stages fired.

In 140 seconds of powered flight, the 50-ton Thor first-stage rocket, with a 150,000-pound-thrust Rocketdyne engine, rose to a height of 50½ miles. During this ascent, the direction of climb was established by swiveling the main booster combustion chamber on its gimbals, and differential control was achieved by small vernier rockets attached to the main frame.

After cutoff of the first stage, with the missile's speed about 10,000 miles per hour, the explosive separation bolts were detonated. The burned-out first stage and the cowling that had protected the later stages from

Technicians make adjustments as the payload package (fourth stage) and its cluster of vernier rockets are joined to the third-stage rocket. The eight small verniers were fired on radio command from the ground within two minutes after third-stage burnout, to achieve final velocity and direction control of the Pioneer probe.



Detailed explorations of the moon with the aid of rockets may soon supplement optical observations by earth-bound telescopes. Our best records of the lunar surface are photographs such as the one shown here in part, taken with the 100-inch Mount Wilson reflector. Filling the right half of this view is the smooth expanse of Mare Nubium. Noteworthy are the "ghost rings" — craters that have apparently been almost completely covered by a later flow of lunar material. The bright line of light near the center is the Straight Wall, an escarpment 60 miles long and about 1,000 feet high. The prominent flat-floored crater at bottom center is Alphonsus, and above it is Alpetragius. Bullialdus is about three-quarters of an inch from the right edge and a little below center. The detailed nature of these striking formations and the true history of their origin are controversial puzzles that may be clarified by actual visits to the moon in the foreseeable future.

aerodynamic friction were thus cast off, and the second-stage liquid-fuel Aerojet-General 1040 propulsion system took over. Eight small rockets imparted spin to this 4,000-pound assembly, which ascended to a height of 163.1 miles. The second-stage cutoff was controlled by an accelerometer, which had no way of detecting the improper climb angle. It is thought that fuel for another 10 seconds of powered flight remained when the second stage was cut off — enough to have imparted the additional velocity needed for an approach to the moon. In later launchings it is probable that cutoff will be remotely controlled by a ground-based computer.

The third stage used a solid-propellant rocket motor newly developed by the U. S. Navy's Allegheny Ballistics Laboratory. Weighing 400 pounds, this rocket provided about 2,500 pounds of thrust, and carried the missile to a height of 221 miles at third-stage burnout. Explosive bolts separated the Pioneer package, and a few minutes afterward its eight small vernier rockets were operated by command signal from the ground to provide small adjustments in attitude and velocity. Thereafter, the package was on its way, but its peak velocity of 23,300 miles per hour was some 570 short of that intended.

By command signal the final verniers were jettisoned. The reverse-acting fourth stage that failed to fire (because of lack of battery power) had a Thiokol engine developed by Space Technology Laboratory. This organization was in over-all charge of the entire missile assembly and of ground tracking.

MARSHALL MELIN

Amateur Observations of Pioneer

Two well-known amateur astronomers in Washington, D. C., were able to secure both radio and visual observations of the early moments of the Pioneer rocket flight. They were G. R. Wright and Robert McCracken, president of the National Capital Astronomers.

For some time, the two have been making systematic recordings of the radio signals from several artificial satellites. They recorded the 77-second flight of August 17th. On October 11th, they had met at Mr. Wright's home in Silver Spring, Maryland, at 4:00 a.m., planning to repeat their program for the expected launching about 4:40 a.m. Eastern daylight time.

Hugh Fitzpatrick and Mr. McCracken had previously computed the proper direction toward which to point the antenna system, which consisted of two five-element Yagis, set half a wave length apart and horizontally polarized. This direction was a little east of the line to Cape Canaveral, and about 15 degrees above the horizon.

At 4:43, they heard over the commercial broadcast band an announcement that the Pioneer rocket had blasted off, and a minute later they began to record the

continuous wavering note, similar to those they had received in the past from all the American satellites on 108 megacycles. At 4:46, Mr. McCracken went outside with binoculars for a visual observation.

To his surprise, with the naked eye he saw in the southeast a small white cloud, about 20 degrees above the horizon. Shining in a perfectly clear sky, it was in total brightness like a 2nd-magnitude star. Its diameter of several degrees was increasing rapidly. Mr. McCracken believes the phenomenon resulted from the explosion of the first-stage rocket as it re-entered the lower atmosphere; he saw something falling earthward below this cloud, presumably remnants of the first stage.

When Mr. Wright and his wife came out to see the cloud, a comet-like object was visible in binoculars, moving toward the eastern horizon. This was probably the missile, the later stages of which were still firing as it rose into space. The entire visual observing sequence lasted about four or five minutes. The sighting azimuths and altitudes were consistent with the course of the Pioneer vehicle and with the distance from Washington, D. C., to Cape Canaveral.

The spectacular ascent of the Pioneer rocket was seen by the passengers and crew of a Northeast Airlines Boston-to-Miami plane. The DC-6B Sunliner, with 69 persons aboard, was flying at 18,000 feet about 85 miles east of Charleston, South Carolina, at the moment of launching.

Payload Instrumentation

Pioneer was fitted with a complex array of electronic instruments in order to gather and send to earth different kinds of information. The numbers in the accompanying Space Technology Laboratory diagram indicate some important parts, which may be described under the following headings:

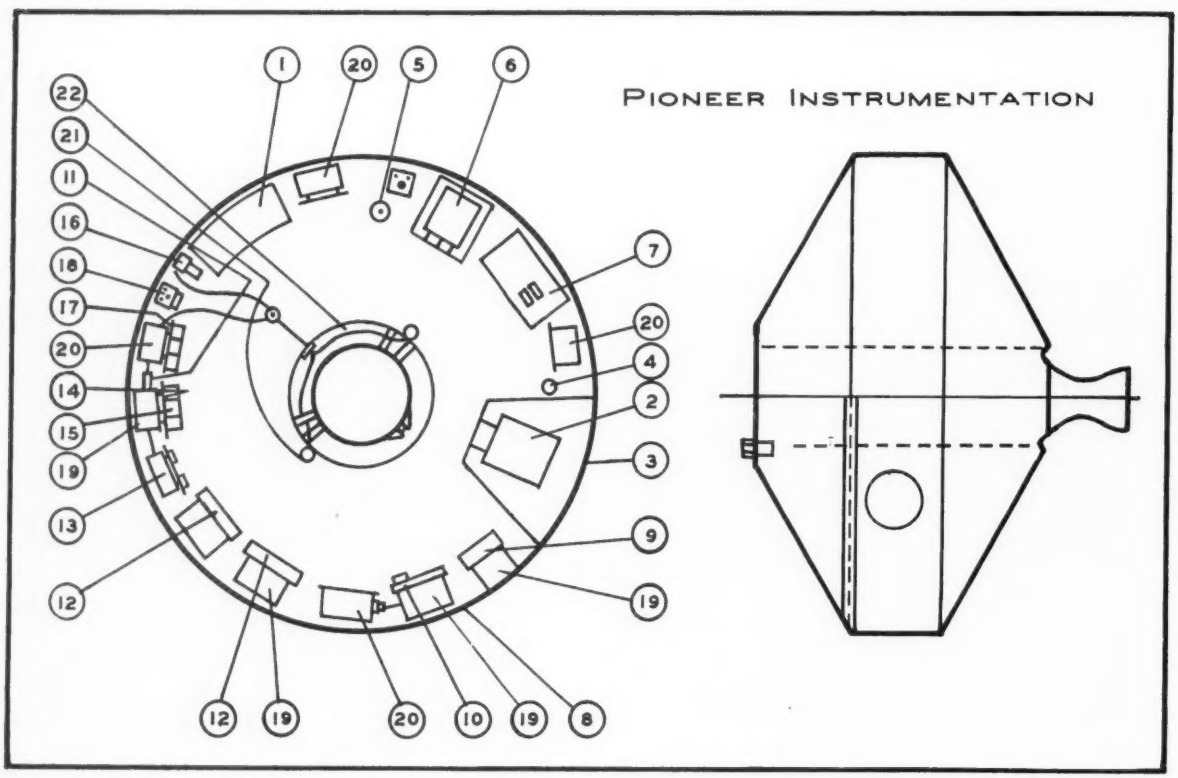
Command Receiver. Instructions to the instrument package from the earth, sent by means of the radar used to measure the Doppler effect in the motion of the vehicle, were received by unit **1.**

Television Apparatus. For infrared scanning of the moon's surface, a television system was employed, consisting of an optical unit **2,** scanning window **3,** driver **4,** final amplifier **5,** and a converter **6** to change the low-voltage direct current supplied by the battery pack and terminal board **7** to high-voltage direct current.

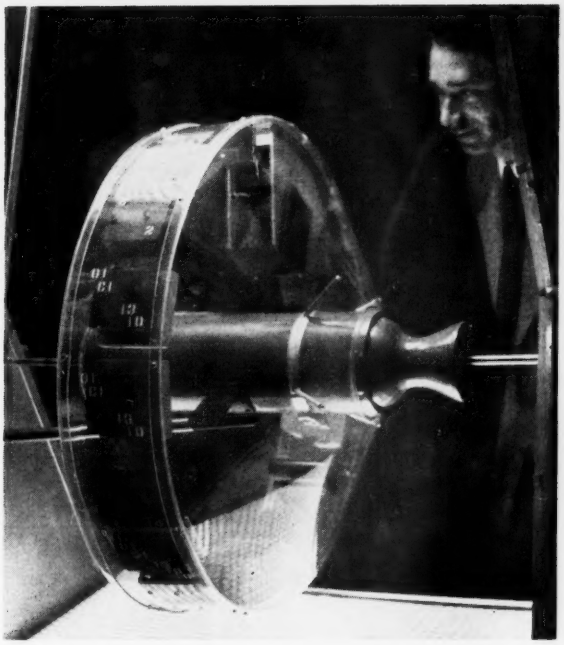
Micrometeorites. Very small particles in space striking the diaphragm **8** of the microphone produced a signal which was amplified at **9** and used to change the signal produced by the subcarrier oscillators **10.**

Magnetometer. To measure the magnetic fields of the earth and moon, the magnetometer consisted of a sensor coil **11,** an amplifier **12,** and a set of subcarrier oscillators **13.**

Compartment Temperature. Sensing devices for meas-



Spaceflight demands that instruments and power supplies be as light and compact as possible. The manner in which the Space Technology Laboratory of the Ramo-Wooldridge Corporation arranged the components of Pioneer is shown by this diagram. At the right is a side view of the instrument compartment and retro-rocket nozzle. Compare the pictures on the facing page with this diagram, which was included in a public exhibit in the Pentagon building, Department of Defense.



This model of the instrument package was designed and set up in the Pentagon public lobby by the Orientation Group, Wright-Patterson Air Force Base. Sky and Telescope *photo.*

uring the compartment temperature actuated another subcarrier oscillator **14.**

Telemetry to Earth. All of the information from the subcarrier oscillators then passed through the low-pass filters **15,** diplexer **16,** and multiplexer **17** to the telemetry transmitter **18,** which was powered by a battery **19** and removable extra-life batteries **20.** The final signal was fed to the telemetry antenna through connection **21.**

Retro-Rocket. If the probe had reached the vicinity of the moon, a rocket fitted in the center of the instrument package would have been fired to slow its motion in order to permit it to circle the moon. The damper ring **22** isolated the instrument chamber from the retro-rocket. Not shown are a pressure-sensing device in the rocket chamber, designed to indicate that this stage had fired, and a spin-rate sensor.

Sterile Lunar Probes

The instrument packages of Pioneer and its ill-fated August 17th predecessor were sterilized chemically and, for the later vehicle, with intense radiation. This step, taken in accordance with international agreement, was to prevent chemical, nuclear, or biological contamination of the moon that could hamper scientific exploration of our satellite.

For example, unless such precautions were followed, it would never be certain whether any large organic molecules that might be found on the moon were not brought by terrestrial missiles. Similarly, a nuclear explosion on the moon might make it impossible for a future expedition to determine the ages of lunar rocks by measuring their radioactivity. Also, a "soft" lunar landing, in which a vehicle would spend tons of fuel for braking, could so contaminate the tenuous trace of lunar atmosphere that its true composition would remain undiscoverable.

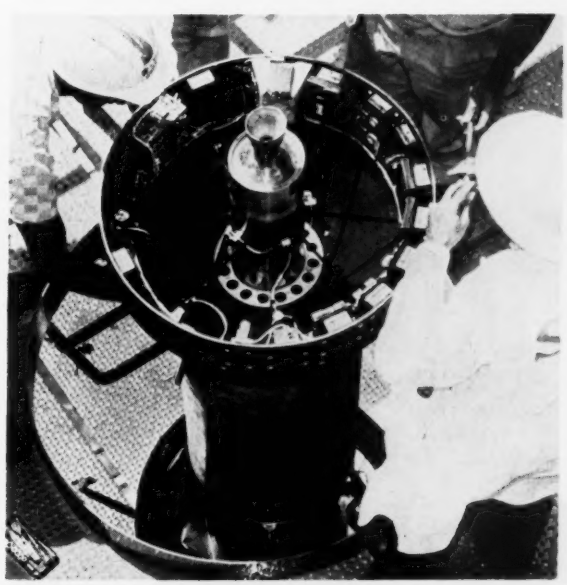
Procedures to avoid spoiling the moon for future scientific purposes have been formulated by the Committee on Contamination by Extraterrestrial Exploration (CETEX). This group, which is affiliated with the International Council of Scientific Unions, met in Holland during May, and at Washington, D. C., in October.

Tracking the Probe

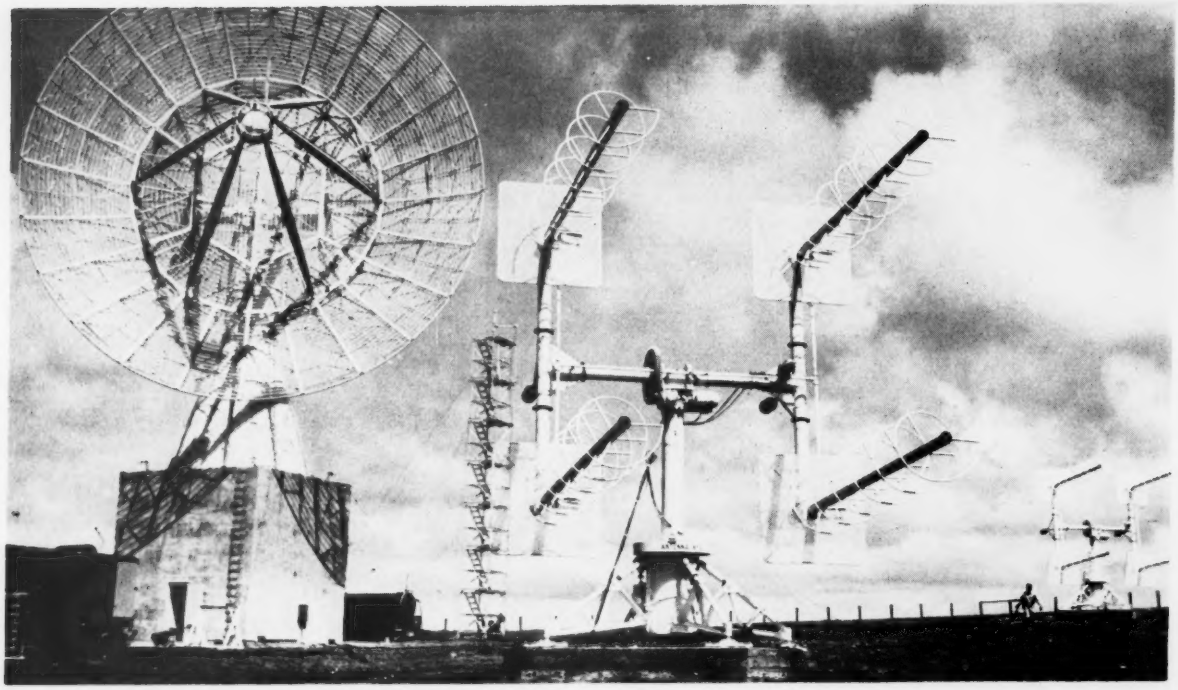
One of the most impressive aspects of the October 11th performance was the excellent co-ordination among the tracking stations, data analysis center, and news dissemination facilities.

The five primary radio-tracking stations were in continuous two-way teletype contact, with one another and with the data reduction center of Space Technology Laboratory, located at Inglewood, California. The nine Minitrack stations operated by the Naval Research Laboratory reported to their operations center at Cape Canaveral, which relayed the data to the California nerve center.

Because of the unprecedented distance to which the fact-finding missile was to travel, exceptional measures were needed to assure reception of its telemetered signals. Pioneer's transmissions on 108.06 megacycles — the frequency agreed upon by the IGY — were recorded by five of the largest steerable antennas available in the world. These primary stations, which monitored the probe continuously up to 3:46 Universal time on October 13th, minutes before its destruction in the atmosphere, are at Cape Canaveral, Florida; Millstone Hill, in Massachusetts; Jodrell Bank, near Man-



Final phases of the payload-package assembly are under way in this picture, taken from the top of the gantry crane while the rocket was standing on the launching ring. The retro-rocket is pointed upward in the center of the configuration. U. S. Air Force photograph.



The Kanae, Hawaii, installation was one of the five primary tracking stations around the world that were tuned to radio signals from Pioneer. It employs a 60-foot parabolic unit, shown at the left, and four helical antennas (two seen here), each of which consists of four helices that move as a unit in altitude and azimuth. The Hawaiian station was the last to monitor signals upon the descent of Pioneer over the Pacific Ocean on October 13th.

In England the world's largest steerable radio telescope, the 250-foot dish at the Jodrell Bank Experimental Station of the University of Manchester, was used to track the Pioneer in its flight toward the moon and its return to Earth. This night view shows the instrument shortly before its completion almost a year ago.

chester, England; Singapore, British Malaya; and Kanae, Hawaii.

The nine Minitrack stations that helped track Pioneer are located at Ancon, Peru; Antigua, Leeward Islands; Antofogasta and Santiago in Chile; Cotopaxi, Ecuador; Grand Turk, Bahamas; Havana, Cuba; Johannesburg, South Africa; and Woomera, Australia.

The stream of observations of the direction and line-of-sight velocity of Pioneer from these stations flowed into the data reduction center at Inglewood, where the figures were combined and analyzed with an IBM 704 electronic digital computer. From this came the distance and speed values that were so promptly relayed to the public.

The tracking stations made tape recordings of the five channels on which the observations obtained by Pioneer were being telemetered to Earth. Preliminary reports of some of the experiments were quickly made available, in announcements from the Pentagon in Washington, by Louis G. Dunn, president of Space Technology Laboratory, and other spokesmen.

REPORTED DISTANCES OF PIONEER
From the earth's center

Date	*UT*	*Miles*	*Date*	*UT*	*Miles*
Oct. 11	8:42*	4,000	Oct. 11	20:47	65,000
	9:48	12,300	Oct. 12	2:47	74,700
	10:47	20,300		4:47	77,700
	11:47	27,500		8:42	79,100
	14:47	44,400		20:47	54,400
Oct. 11	16:47	52,100	Oct. 13	3:46†	?

*Takeoff. †Last radio observation before final fall.

markings, the amateur needs patience and persistence. Observations should be attempted on every night when seeing conditions are favorable. I find it a good plan to observe the planet for at least 15 minutes before beginning any sketching. This preliminary watch enables the eye to become fully adjusted to the glare of Mars, and makes delicate features easier to detect.

Color filters are helpful, as C. F. Capen, Jr., explained on page 517 of the August issue. I use a Harrison-Duraline #2 RD4 orange filter or a Wratten 23A red filter to increase the visual contrast between the desert and mare regions, and also to lessen irradiation. An Eastman Kodak deep blue filter makes the Martian disk faint, but enhances the polar caps and the mists surrounding them, and helps show white areas near the limb and terminator. It is useful in detecting visually any occurrence of the famous "blue clearing."

Drawings of Mars should be of generous size, with the planet's disk at least two inches in diameter. Beginners often use too small a scale. The drawing should always contain only what is actually seen through the eyepiece, and not what some map may show.

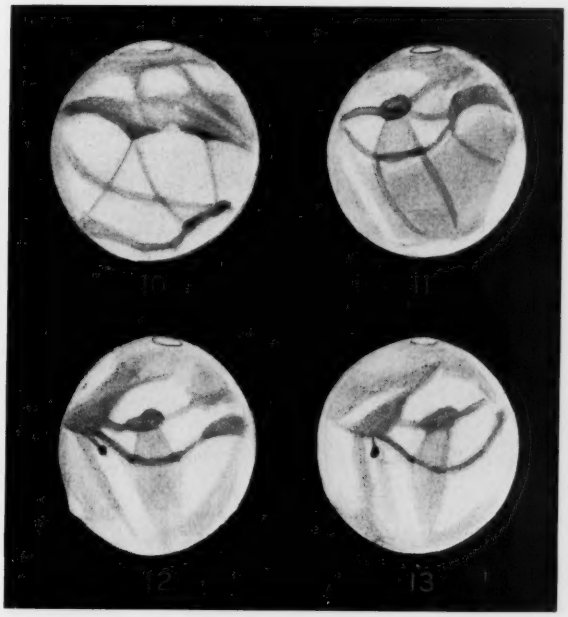
My observations of Mars in 1958 began during the mornings of late April, but the red planet was far from the earth and the brilliant south polar cap was the only conspicuous marking. The telescope used for all my work so far this year is an 8-inch f/7 Newtonian reflector with electric drive, setting circles, and rotating tube.

No drawings were attempted until June 21st, when the angular diameter of Mars was eight seconds. The dark band about the south cap was conspicuous, and the maria appeared of normal contrast (see drawing No. 1).

By the beginning of August, the diameter was 10 seconds, about the minimum for serious study. On several occasions, the extensive areas Hellas and Elysium appeared very white when seen near the limb (2). Mare Cimmerium and Mare Tyrrhenum were very dark along their northern borders (3), while the tip and western side of Syrtis Major were among the darkest portions of the planet (7 and 8). In the northern deserts, Trivium Charontis and Cerberus were very obvious (9), and I even saw them on two nights in early September with a 3¼-inch Brashear refractor at 250x.

From August 10th to about the 22nd, the south cap looked hazy, as if partially mist-covered, but was brilliant though small during the remainder of the month. While the dark band was not seen with certainty after August 10th, on three occasions since September 13th a very narrow dark band was suspected surrounding the tiny remnant of the south polar cap.

The region between longitudes 300° and 60° (6), which includes Sinus Sabaeus, Margaritifer Sinus, and Aurorae Sinus, presented its normal appearance, though on a few mornings the first-mentioned looked lighter than expected. Mare Serpentis and part of Hellespontus have been very dark (6 and 7). Oxia Palus, the large dark oasis north of the tip of Margaritifer Sinus, has been an unusually easy object (5).



More drawings by the author with his 8-inch reflector. For each is given the 1958 date, UT, seeing, power, Martian diameter and central-meridian longitude: 10, Sept. 11, 7:45, 7-8-9, 500x, 13″.6, 170°-180°. 11, Sept. 19, 8:45, 5-6, 500x, 14″.4, 108°. 12, Sept. 20, 7:45, 8-9, 360x-500x, 14″.5, 88°. 13, Sept. 21, 7:30, 8, 360x, 14″.6, 67°.

All the "canals" I saw during the early part of the 1958 apparition of Mars seemed rather wide and diffuse, except for those in the desert north of Sinus Sabaeus. These were narrow and dark, being described on August 27th (6) as very well defined.

Of particular interest is Nodus Laocoontis (labeled Thoth on the IAU map on page 23), the major dark area that has grown to prominence in recent years (*Sky and Telescope*, August, 1956, page 442). In 1956, when the north pole of Mars was tilted strongly away from us, this region could be only poorly observed. As this year it is well placed for viewing, it deserves close attention (8 and 9).

Another Martian feature that has changed is Solis Lacus. In 1956 it was a long oval, pointing nearly east-west, but observations this September (11, 12, and 13) indicate it now bends considerably from southern Nectaris. The nearby oasis Juventae Fons was beautifully seen on September 21st and 22nd (12 and 13), a tiny round dot that was certainly the very darkest marking on the surface of Mars.

Near dawn on September 16th, Walter H. Haas reported a large cloud over Ausonia, part of Mare Tyrrhenum, and part of Syrtis Major. Unfortunately, I could not observe this region the next morning. On September 20th (12), I saw a small, very bright projection on the terminator — probably a cloud high in the Martian atmosphere. It was first visible at 7:07 UT, and was very plain at 7:52 when fog over Long Beach, California, halted observation. On the next night, when the same region of Mars was again on the terminator, a close search revealed no trace of this projection.

The blue clearing is the occasional abnormal transparency of the Martian atmosphere at short wave lengths. When it occurs, blue-light views show the surface

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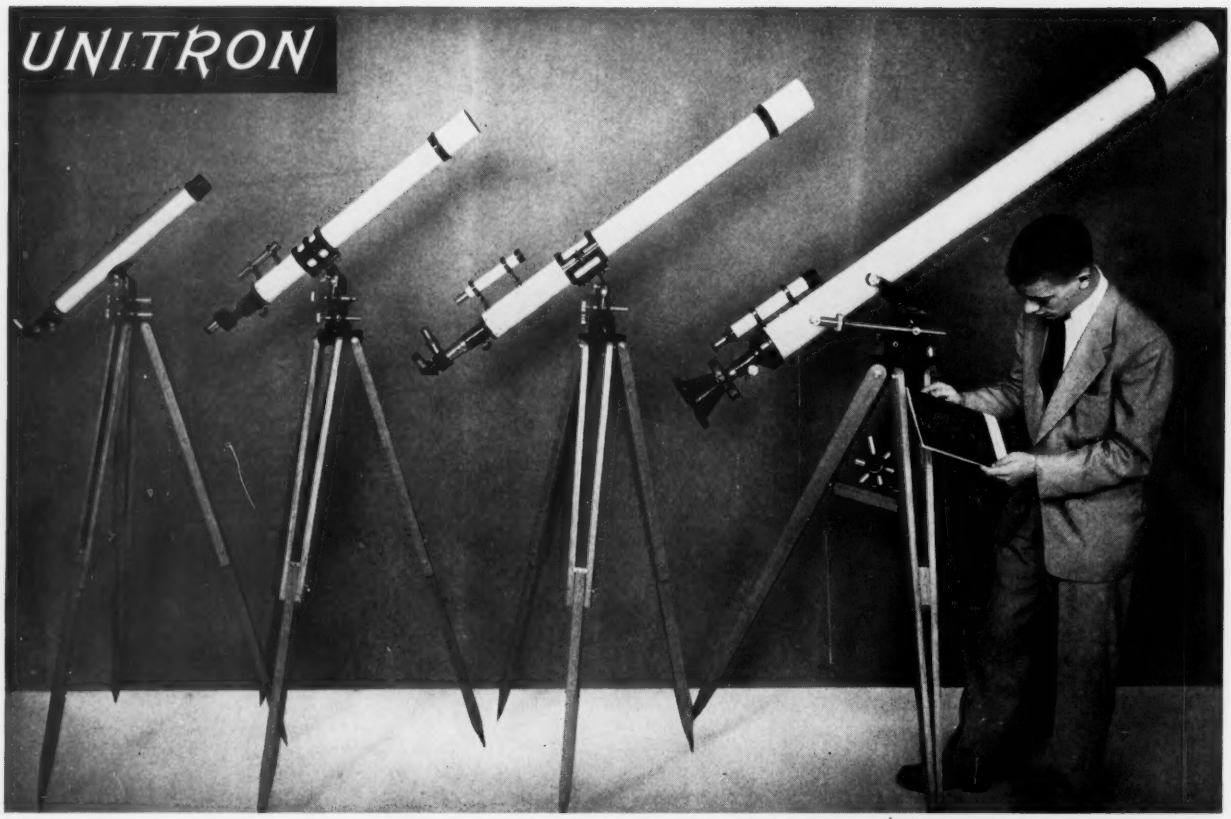

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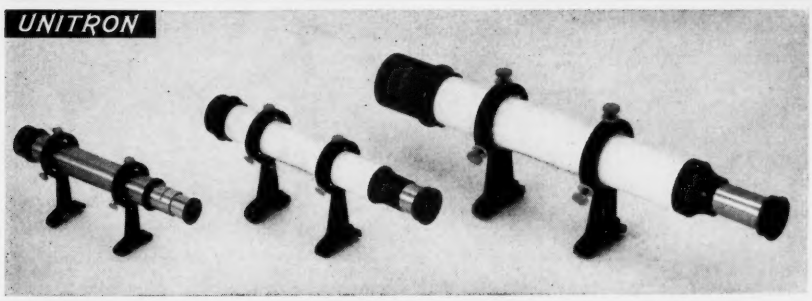

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markings instead of just a featureless disk. Until 1954, the blue clearing was thought to occur only at the time of opposition, but co-operative observations obtained evidence of it on several dates considerably earlier. In 1956 G. de Vaucouleurs, observing in Australia, found that the blue clearing is not always planet-wide, as had been believed, but may occur over only a part of one hemisphere.

Since early August, every night that I observed Mars I inspected the planet through a Kodak deep blue filter to look for the blue clearing. Ordinarily this showed only the south cap and some vague white areas near the north limb. On August 29th I suspected a clearing, for Syrtis Major was faintly visible through the filter. On September 19th and 20th, Solis Lacus and its surroundings were definitely visible in deep blue light, and in the darker mare detail was quite easily seen.

In early September, R. S. Richardson took photographs with the 60-inch Mount Wilson reflector showing definite evidence of a blue clearing, and visual observations of the phenomenon were made by Alika K. Herring of South Gate, California.

The very favorable 1956 opposition of Mars was disappointing to many observers because of the apparent faintness of the dark markings. When Mars was closest to the earth in September that year, much surface detail was obscured by a great yellow cloud, the most extensive and long-lasting in the history of Martian observations. My studies this year consistently show that better views of the dark maria can be expected through the coming autumn and winter months, for in general they appear of normal contrast and intensity.

THOMAS R. CAVE, JR.
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Long Beach 4, Calif.

DEEP-SKY WONDERS

WHEN cool, crisp November skies roll around, new delights await the amateur. On a clear, moonless night he shows his friends the great spiral galaxy in Andromeda, and perhaps M33 in Triangulum, both described on page 637 last month. The former is an impressive sight in low-power binoculars and telescopes.

While his friends locate the famous Double Cluster in Perseus with the unaided eye, the amateur swings his telescope to it, at right ascension $2^h\ 17^m$, declination $+56°\ 54'$ (1950 co-ordinates). There, in a low-power, wide-field eyepiece, the brilliant double swarm of suns, h and χ Persei, brings exclamations of wonder and appreciation from the viewers.

Next, after a long pause to scan the orange disk of Mars, he turns the telescope to the Pleiades, and puts on his lowest-power ocular. By tradition, the host asks his visitors to make a naked-eye count of the Seven Sisters before looking through the telescope. If the night is extremely clear, he may even glimpse the very faint nebulosity surrounding the star Merope in this open cluster.

But eventually his friends get tired, and go home to the children or television, and the amateur tries a really hard one for himself: the faint spiral galaxy NGC 16, at $0^h\ 06^m.5$, $+27°\ 27'$, just south of Alpha Andromedae. As it is tiny and of the 12th or 13th magnitude, locating this object gives a feeling of accomplishment.

WALTER SCOTT HOUSTON
Rte. 3, Manhattan, Kans.

SUNSPOT NUMBERS

The following American sunspot numbers for August have been derived by Dr. Sarah J. Hill, Whitin Observatory, Wellesley College, from AAVSO Solar Division observations.

August 1, 240; **2,** 240; **3,** 216; **4,** 178; **5,** 217; **6,** 238; **7,** 235; **8,** 211; **9,** 235; **10,** 240; **11,** 192; **12,** 189; **13,** 180; **14,** 155; **15,** 191; **16,** 198; **17,** 177; **18,** 149; **19,** 136; **20,** 142; **21,** 161; **22,** 174; **23,** 190; **24,** 185; **25,** 195; **26,** 161; **27,** 175; **28,** 184; **29,** 166; **30,** 193; **31,** 209. Mean for August, 192.0.

Below are observed mean relative sunspot numbers from Zurich Observatory and its stations in Locarno and Arosa.

September 1, 200; **2,** 221; **3,** 230; **4,** 240; **5,** 206; **6,** 220; **7,** 175; **8,** 160; **9,** 166; **10,** 219; **11,** 245; **12,** 268; **13,** 265; **14,** 233; **15,** 230; **16,** 206; **17,** 189; **18,** 205; **19,** 187; **20,** 163; **21,** 156; **22,** 172; **23,** 175; **24,** 174; **25,** 161; **26,** 169; **27,** 177; **28,** 208; **29,** 218; **30,** 189. Mean for September, 200.9.

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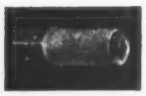

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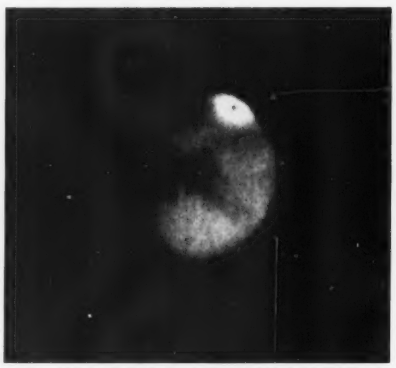
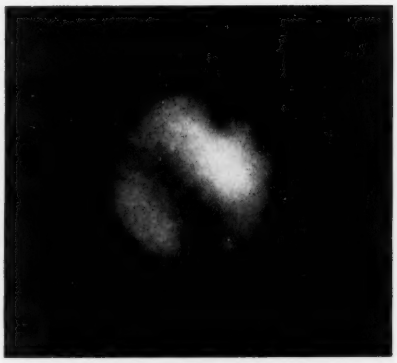
AMATEUR PHOTOGRAPHS OF MARS

DURING the favorable opposition of Mars in 1956, I obtained a number of photographs of the planet with my 12½-inch reflector through a ¼-inch Ramsden eyepiece. One-second exposures were made on Verichrome Pan film, which was developed in Durol 7. The Zeiss-Ikon camera had a delayed-action shutter release, which allowed time for telescope vibrations to die out before each exposure was made.

The first of the two photographs, reproduced below, was taken on August 12, 1956, at 1 a.m. Central standard time, when the longitude of the Martian central meridian was about 306°. Because this was almost a month before the date of opposition, Mars showed a distinct phase, the west (left) limb being unillumi-

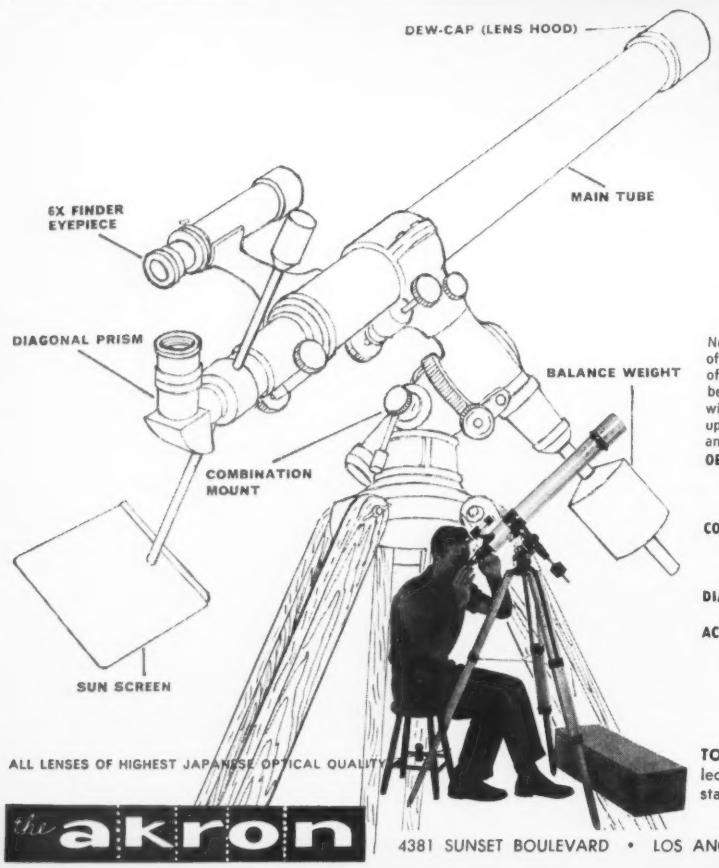


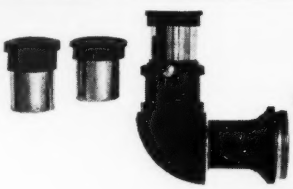


nated. The south polar cap is bright and prominent. The dark markings to the left and right of the center of the disk are Syrtis Major and Sabaeus Sinus, respectively.

The picture above was taken on September 19th, at 10 p.m., with Martian longitude 275° on the central meridian. At this time the apparent diameter of Mars was 24 seconds of arc, the planet being so near opposition that the phase was inappreciable. The south polar cap is not detectable. Syrtis Major appears as a large dark triangle in the lower part of the disk, and above it is the conspicuous light region, Hellas.

EVERETT S. OLIVER
504 Harvey St.
Danville, Ill.





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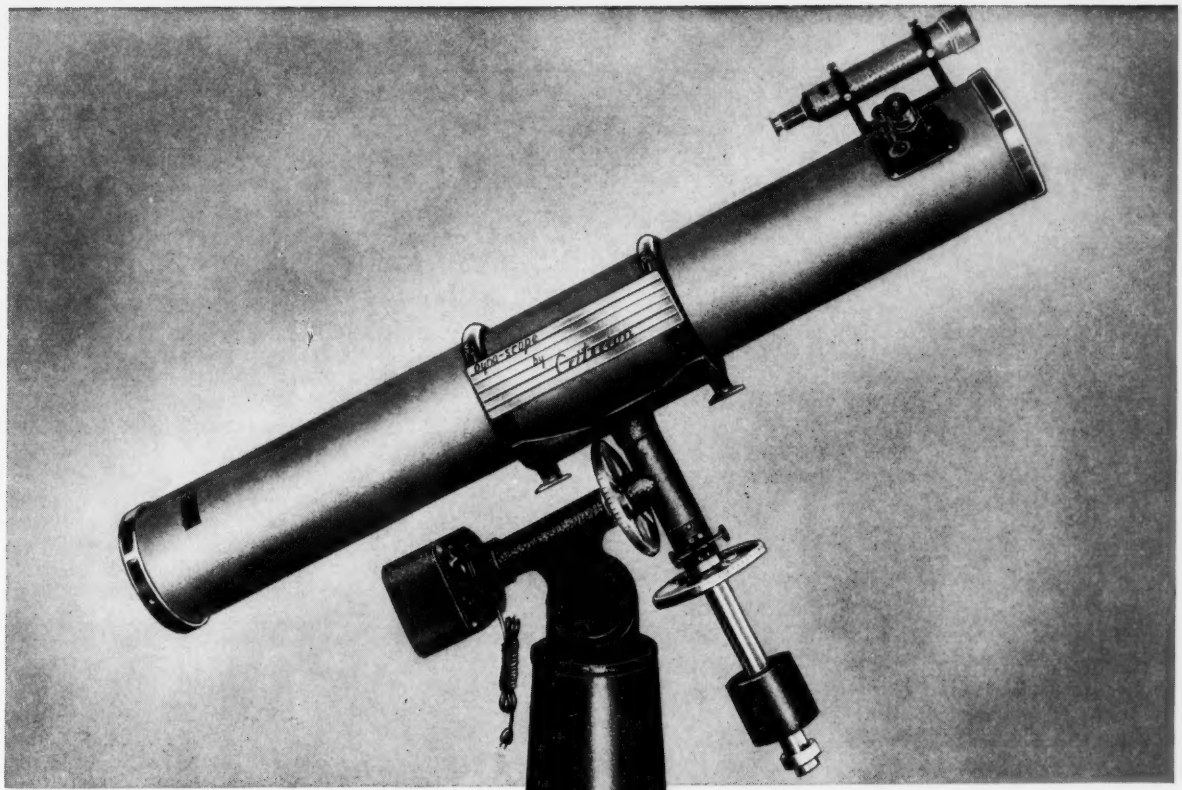

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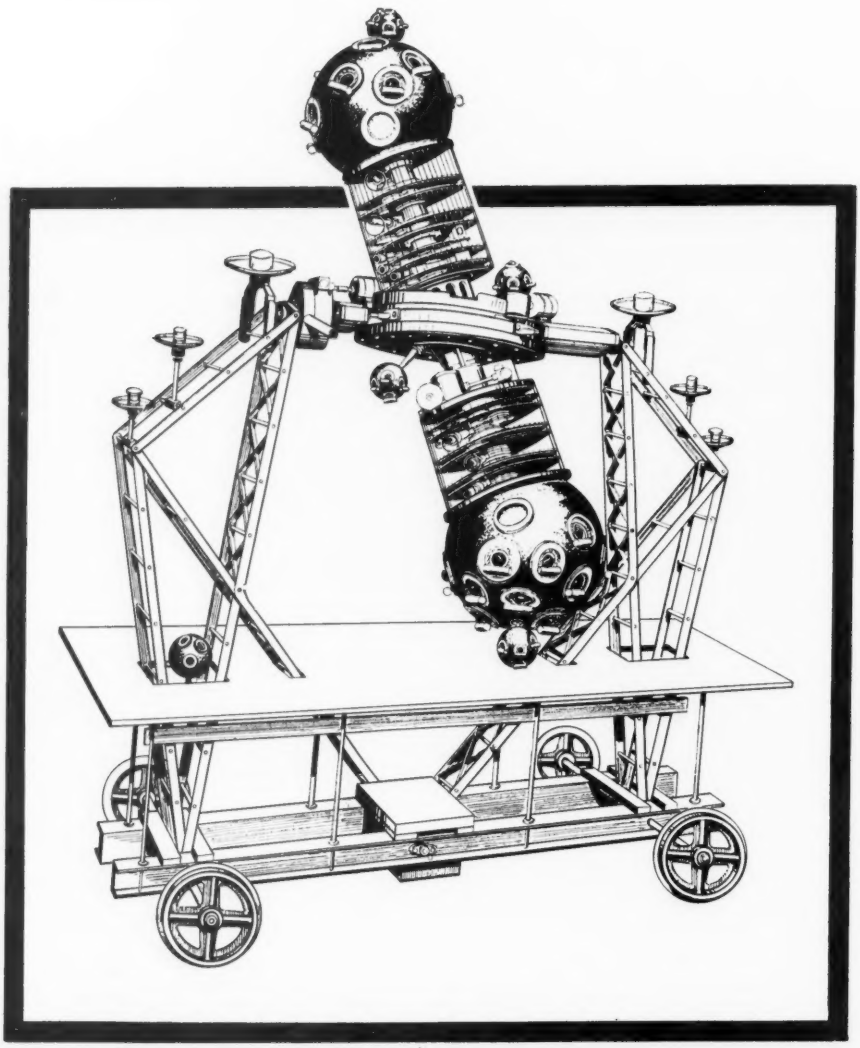

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BOOKS AND THE SKY

OF STARS AND MEN

Harlow Shapley. Beacon Press, Boston, Mass., 1958. 157 pages. $3.50.

A STRONG CASE could be made for the thesis that man's restless intellectual drive is motivated by uncertainty as to his place in the natural scheme. *Of Stars and Men* is Harlow Shapley's appraisal of the horizons that rational man has attained in his quest for perspective and orientation.

Why should a man whose career has been devoted mainly to astronomy be so actively interested in the origin of life and its role in the universe? Without pretending to speak for this book's author, I venture the opinion that he has been motivated, not by a curiosity about the stars and galaxies *per se,* but by that broader concern to know "what is man, and whither are we bound?" Our more impressive lessons in humility and first intimations of cosmic grandeur began with the stars, and astronomy is still a good place to begin if we are looking for perspective.

About three decades ago, Dr. Shapley approached his present theme in *Flights from Chaos,* a small book based on a series of lectures given at the College of the City of New York. To the animate portion of the universe he devoted a remarkable two-paragraph chapter entitled "Note on Organic Colloidal Aggregates." In his latest book, the proportions are interchanged, an up-to-date survey of the inanimate universe serving as background for inquiry into the role of life and intelligence in the physical world.

The author traces the three great adjustments in perspective that man has had to make since his early illiterate cultures. Each of these has required acceptance of a more peripheral position for man, first with the geocentric concept, then the heliocentric system, and lately the galactocentric cosmos.

The fourth adjustment is today's realization that we are not alone in a hostile universe, that the peculiar organization of matter that we call living is as "natural" and pervasive as are the solid, liquid, and gaseous states. The processes by which inanimate matter can be expected to evolve into living organisms have been intimated with sufficient clarity to dispel any need for a miracle to explain the origin of life on earth. Parallel developments in astrophysics indicate that planets are not rare but commonplace.

The inescapable conclusion is that what has happened on earth has happened, and will happen, elsewhere. Although this fourth adjustment deprives man still further of his pretensions to uniqueness, like the earlier shifts of perspective it evokes an awareness of undreamed-of grandeur in which we all participate.

Dr. Shapley supports his position with a comprehensive summary of the fundamental cosmographic information that has accumulated in astronomy, physics, chemistry, geology, biology, and other fields. He deliberately limits his discussion to the physical entities of space, time, matter, and energy as the framework of the cosmos. He traces our orientation in space and time, our comprehension of the structure of matter and the energetic relations among material systems.

Man is fortunate, he points out, to have arrived on an old planet with a telltale past. On a virgin planet without previous life or geological evolution there would be no signposts to mark out the dimension of time. But man is a late-comer on a world already old when the first life began. Everywhere, in the dying radioactivity of the rocks, in the topsy-turvy pages of the book of sediments, in the fossil memories of the living past, we find the long trace of time. Recently, the geological calendar has linked up excitingly with the timetable of stars and galaxies, and half a dozen lines of evidence agree on a crucial time of vast beginnings a very few billion years ago.

Although realizing that life chemistry and structures on some planets may be radically different from those on earth, Dr. Shapley believes life on other worlds depends on the basic compounds of carbon and a few light elements that are the matrix of terrestrial living matter.

Man he recognizes as a creature of remarkable potentiality, because of the greatly specialized development of his brain and his awareness and intelligence. Yet he cautions against attributing too much superiority to man, pointing out the loss of the complex instinctive behavioral wisdom that is so highly developed in many "lower" organisms. He also emphasizes the handicap of man's inferior sensory equipment.

I am inclined to question this assessment of man's position. It is just his lack of highly developed instinctive patterns, I believe, that frees his rational mind and enables the human species to transcend the slow adaptive processes of organic evolution, avoiding physiological specialization with its inexorable penalties.

Man's cognitive equipment, too, may include some unrealized reserves. Dr. Shapley notes that "there are those among us who dream of vestigial or embryonic senses hovering about the human psyche." From one who is trying to evaluate the significance of man in the natural order, this comment seems inadequate to take account of the demonstrations by many quite wakeful investigators of cognitive facilities that are not mediated through any known sensory mechanisms.

On questions of philosophy and religion, the retired Harvard astronomer is frank but circumspect. He dismisses the anthropocentric dogmas of the past as

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irrelevant, but he is equally cool toward instituting new dogmas based on scientific findings. While he constructs his current picture of the cosmos on the framework of space, time, matter, and energy, he doubts that these are enough for a full insight. He suggests the need for a fifth entity, "something that would make click a universe of stars, organisms, and natural laws that otherwise might be clickless." He anticipates also the need for a fifth adjustment in perspective that will transcend the current physical and biological orientations.

"It is my own belief (or is it fancy?) that the central theme of biological existence is to grow in refined complexity, in durability, in adaptability. Man as half beast, half angel, must comply with the biogenetic common law, but he is able to make amendments thereto. . . . It is probable that the men of the future will overcome our shortcomings and build out of our thoughts and acts a finer mental and social structure — one that is in better keeping with Nature's heavy investment in the locally dominant human race."

J. H. RUSH
High Altitude Observatory

PLANETS, STARS AND SPACE

Joseph Miles Chamberlain and **Thomas D. Nicholson.** Creative Educational Society, Mankato, Minn., 1957. 223 pages. $7.50.

ASTRONOMY with a minimum of text and mathematics is the theme of this book. In the introduction, the authors call the photograph one of the wonderful features of modern astronomy, and they use pictures to very good effect. Almost all of the right-hand pages are full-page illustrations of astronomical views through large telescopes, pictures of observatories and instruments, or charts and diagrams to accompany the text.

The first of the book's eight chapters deals with the earth as a planet, its physical dimensions, characteristics, and motions. Such phenomena as northern lights, fireballs, and meteorites, are also discussed. Before they proceed to the other members of the solar system and more distant heavenly bodies, the authors devote a section to modern astronomical instruments.

The moon is then discussed, with inspiring closeup views of its surface. Tides and eclipses are also covered. A chapter tells of the sun as a star and as the center of our planetary system.

There follows a description of the various types of stars and star groups in our own galaxy, the Milky Way. The final chapters concern other galaxies and the constellations.

Because of its "unit" style, the book on the whole may seem disconnected, but this is a valuable feature for the person who must get his reading on the run, so to speak. Each page is a unit, on some specific topic related to the facing picture. With the aid of the comprehensive index, the reader can turn to any subject and find the answers to specific questions, or can study one or more sections as time and inclination permit. The illustrations are in an attractive dark blue, and a maroon cover complements the fine printing.

It is noteworthy that little attention is given to space travel, which is a relief from those recent books that present many pages of imaginative material and artists' drawings with scant regard for facts or reasonable theories.

EDWARD J. NEWMAN
324 W. Yakima Ave.
Yakima, Wash.

FRONTIERS IN SCIENCE

Edward Hutchings, Jr., editor. Basic Books, Inc., New York, 1958. 362 pages. $6.00.

THIRTY ESSAYS by scholars, most of whom have been associated with California Institute of Technology, are collected in this book. The essays are presented under three major headings, biological, physical, and social, and include such widely different topics as the philosophy of laughter and the creation of elements in the interiors of stars.

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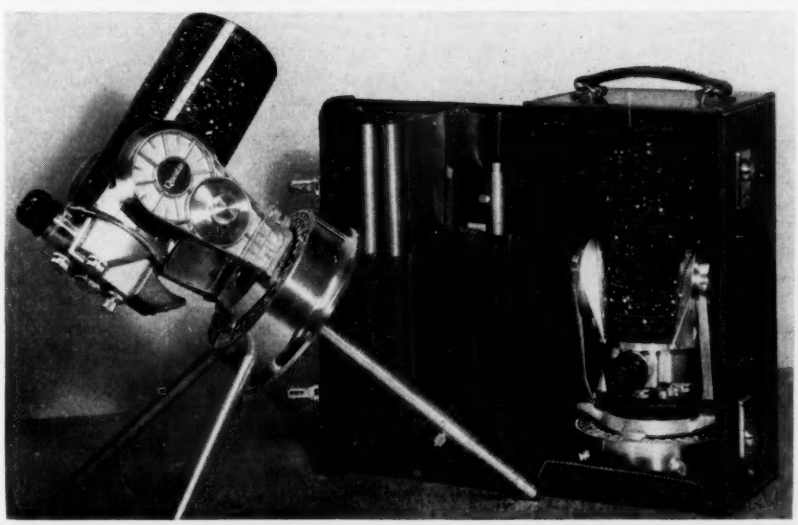

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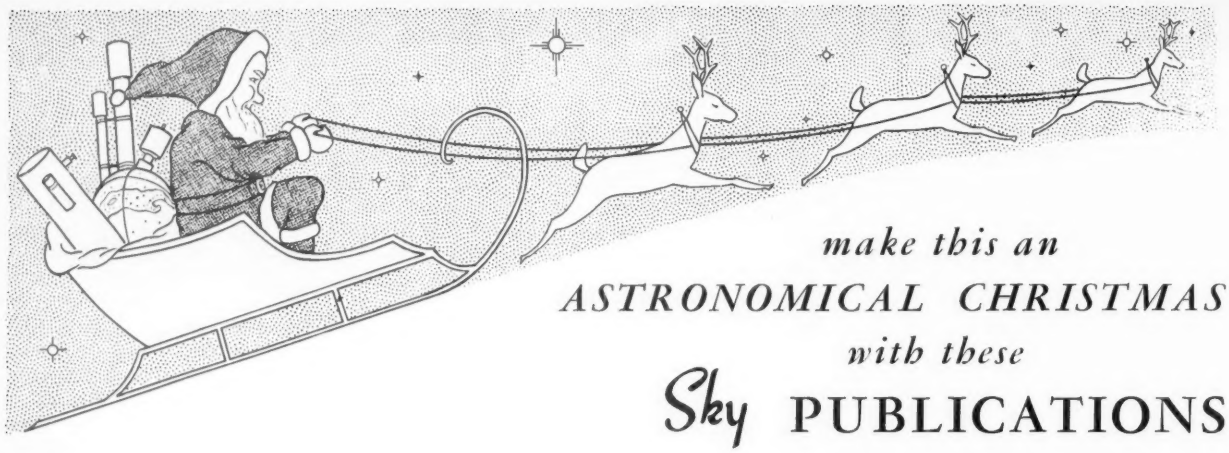

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This popular, yet authoritative magazine on rockets, astronautics, and space-travel astronomy, is written especially for the layman and is edited by Patrick Moore of the British Interplanetary Society. Leading authorities provide comprehensive coverage of all the fields of science that play such an important part in this thrilling adventure of mankind. Rocketry, space medicine, atomic fuels, radar controls, the exploration of the planets are all treated in nontechnical language.

Spaceflight is printed during October, January, April, and July. Please specify the issue with which your subscription should start. Back issues to Vol. 1, No. 1, October, 1956, are available.

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Popular Star Atlas — **Color Map of the Northern Heavens**
Splendors of the Sky — **Lunar Map**

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For the Advanced Observer

These three publications belong in all observers' libraries. **Field Edition Atlas of the Heavens** has 16 unbound charts, 12 by 18 inches, showing white stars (to magnitude 7.75) on a black background. **Atlas of the Heavens Catalogue,** with positions for epoch 1950.0, lists stars, clusters, nebulae, planetaries, and galaxies; also includes the Messier list and many useful tables. **Elger's Map of the Moon** is a large, canvas-mounted chart, identifying all the important lunar features, with notes by H. P. Wilkins on 146 of the more interesting areas.

Field Edition Atlas of the Heavens
Atlas of the Heavens Catalogue
Elger's Map of the Moon

A retail value of $13.25 for **$12.00**

For the ATM and Observer

Here are two books for the telescope maker who plans to observe with his completed instrument. **Making Your Own Telescope** tells him how to make and mount a 6-inch reflector at low cost. **Norton's Star Atlas** covers the whole heavens, showing over 9,000 stars to magnitude 6⅓, along with descriptive lists of 500 interesting objects for viewing with the telescope, and useful data on the sun, moon, and planets.

Making Your Own Telescope, by Allyn J. Thompson
Norton's Star Atlas

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With both amateur and professional astronomers, **Sky Sets I** and **Sky Sets II** have long been favorites. Each set contains 24 large photographs of astronomical wonders, including objects in the solar system and in the Milky Way, portraits of other galaxies, many made with the 200-inch telescope, and drawings of the Hale reflector by Russell W. Porter.

Sky Sets I and **Sky Sets II**
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For All Astronomers

This monumental work belongs on every astronomer's book shelf. **The History of the Telescope** is the first book to tell the full story of the evolution of the telescope, beginning with the crude astronomical instruments of the ancients, to the giants of today. There are 456 pages, including 196 illustrations and extensive references.

The History of the Telescope, by Henry C. King
A retail value of $9.75 for **$7.50**

NOTE: These gift specials are good only in the Western Hemisphere. Offers expire January 31, 1959.

man H. Horowitz traces the history of spontaneous generation, and tells how researchers have projected conditions of the earth's atmosphere back to two billion years ago, at which time, they believe, it consisted of hydrogen, ammonia, methane, and water.

Touching on the problems of feeding the world and of overpopulation, Henry Borsook, a biochemist, argues that present technological advances are sufficient to supply the necessary vitamins and minerals, and that multi-purpose foods now being processed can be made attractive and desirable. On the other hand, Sir Charles Darwin, grandson of the famous evolutionist, is more pessimistic. He believes that the Malthusian relation of too little food for a rapidly growing population will lead to cataclysmic disaster, and that neither technology nor natural sources will provide enough food or fuel for man's needs. However, the English astronomer Fred Hoyle argues against Darwin by minimizing the problems raised; he feels man's ingenuity will meet the situation by determining or limiting populations in some way.

The optimistic note is continued by Harrison Brown, a geochemist, who traces the evolution of the solar system and its planets, and conjectures on the probability of life in the billions of planetary systems in our own and other galaxies. He sees exciting prospects ahead of man learning more of the how and why of his universe, if he can avoid his own destruction.

Lyman Fretwell tells of studies in polar latitudes of cosmic rays that have energies of the order of a billion billion electron volts, as compared with the highest energy particles, five billion electron volts, produced by our largest accelerators.

A form of vegetable life may exist on Mars, according to Frank Salisbury, a plant physiologist, but animal life is not so certain, since it would have to exist in the extremely dry and cold Martian desert. He conjectures that nitrogen, instead of oxygen, would play the active role in energy transfer there.

The Burbidges, Margaret and Geoffrey, write about cosmic alchemy, the creation of the elements in stellar interiors. They discuss stars with light elements, and the red giants with large abundances of heavy elements in their atmospheres or near their surfaces.

The birth, evolution, and death of a star is treated by Allan Sandage. He tells how stars in our immediate neighborhood range in birth date from the beginning of the universe to less than a million years ago, and discusses the determination of age by the rate of the star's exhaustion of energy through nuclear conversion. He theorizes about the birth of a star through the collapse and condensation of a large cloud of gas and dust, with the attendant increase of temperature and density and the consequent nuclear reactions.

Sandage shows color-magnitude diagrams, with stars just at the beginning of their evolutionary life located on the main sequence [see page 17, this issue]. He describes how our sun will evolve in *another* six billion years to where it will have converted 12 per cent of its hydrogen to helium. It will then expand rapidly to about 30 times its present size before it declines in brightness and perhaps becomes a white dwarf.

The editor, Edward Hutchings, Jr., writes about changing ideas on the size and age of the universe. The observational limit with the 200-inch Hale telescope is over one billion light-years, and the estimated age of the universe has been raised from two or three billion to six billion years.

L. A. DuBridge in several essays pleads for new goals; he urges that mathematics be taught more widely so that the layman can comprehend the scientific world. For example, few can grasp the idea of a factor of a million; if we were to count from one to one million at the rate of three numbers a second, it would take nearly four days, counting for 24 hours a day, and to count to a billion would take 10 years.

Ira S. Bowen points out that the value of astronomy is not chiefly in its few direct practical applications, but more in the concept it gives man of his place in the universe.

The book is well written, and for the astronomer or for any other scientist, amateur or professional, it affords an opportunity to obtain a bird's-eye view of the accomplishments of his fellow scientists.

LEON E. GOLD
Amateur Astronomers Association
New York 24, N. Y.

THE BLACK CLOUD

Fred Hoyle. Harper and Brothers, New York, 1957. 251 pages. $2.95.

MANY of this magazine's readers think of Fred Hoyle as the most articulate of the new generation of British astrophysicists. It may be a bit dismaying to

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find the learned exponent of "continuous creation" romping off on a literary lark – he himself calls it a "frolic" – to write this dandy astronomy-fiction mystery thriller complete with attractive girl.

We all know, however, that he has peculiarly strong gifts of expression, and has published books on philosophy and current affairs, in addition to *The Nature of the Universe* and *Frontiers of Astronomy*. And there is a long tradition of serious thinkers using fiction to set forth earnest ideas. Some are now remembered only for their fiction, as is Jonathan Swift and his *Gulliver's Travels*. The fiction of others, like Samuel Johnson and Benjamin Disraeli, is little read today. Finally, Dr. Hoyle had clearly a long list of things he wanted to say, things he had to cast in a form quite different from a report of research findings.

The setting of *The Black Cloud* is pure Palomar Mountain at one end, and England and the Astronomer Royal at the other, with realistic touches that will be appreciated in full by those familiar with astronomy. The time is the near future. After a while the reader will begin to feel the Moonwatch teams might well be alerted to note any odd appearance of a portion of the sky. As the preface states, "After all, there is very little here that could not conceivably happen."

There is unwarranted extrapolation on a magnificent scale, but few will halt at any point in their flight through *The Black Cloud* to say, "This I will not accept." We follow the progress of the cloud and Kingsley, the principal character, with only the breathers a skilled dramatic writer must provide to give added power to the next move.

When we do get a chance to "look around" in the less tense passages, the first question that comes to mind is, "Just how many of these penetrating but harsh opinions of Kingsley are those of Hoyle himself?" It is added mystery to the best cosmic crisis yet concocted.

The Black Cloud tells what Dr. Hoyle was determined to say, related in such a manner that his audience listens to the end.

JOHN W. STREETER
Franklin Institute
Philadelphia 3, Pa.

NEW BOOKS RECEIVED

EXPLORING THE SUN, *Roy A. Gallant*, 1958, *Garden City Books*. 56 pages. $2.50.

Another of Roy Gallant's series for young people, this book uses many large, colored drawings to illustrate ancient beliefs and modern knowledge about the sun.

EXPLORING THE PLANETS, *Roy A. Gallant*, 1958, *Garden City Books*. 123 pages. $2.95.

For young people, this book with its many imaginative illustrations discusses the origin of the solar system and what is known about the planets. It gives tables showing the positions of the five brightest planets for the next 11 years.

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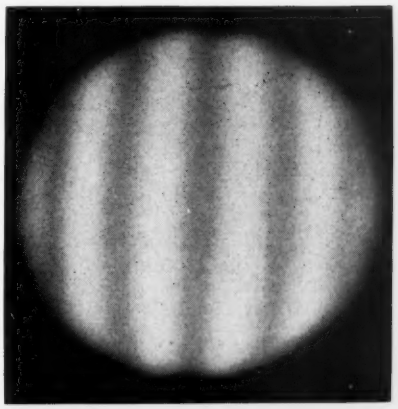

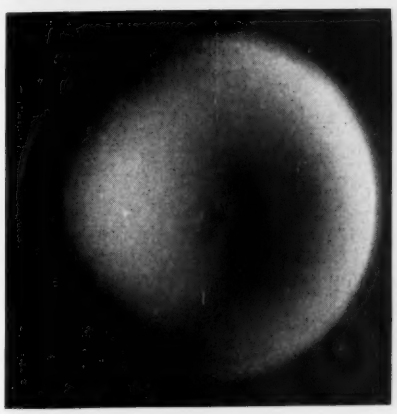

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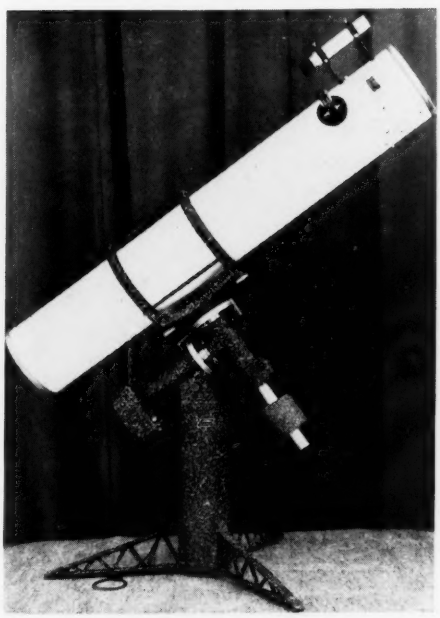

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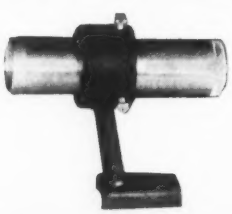

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Balancing the Tube of a Reflecting Telescope

AMONG amateur-built reflectors, statically unbalanced instruments are the rule rather than the exception. While friction in the bearings or restraining clamps on the axles often conceal a lack of equilibrium, such a condition cannot be tolerated if slow-motion controls are to work properly or if a driving clock is to be added.

Recently, this department received a communication from Dr. George Van Biesbroeck, well-known astronomer at Yerkes and McDonald Observatories, in

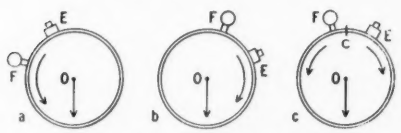

Fig. 1. Conditions of unbalance, the telescope tube tending to rotate one way or the other, except when oriented as in drawing c. Gravity is in the direction of the vertical arrow.

which he describes the procedures for making the final adjustments to balance a telescope in all positions. But before presenting his suggestions (in a subsequent article), it is necessary to discuss the steps an amateur should take to balance the reflecting telescope tube and its attachments around the optical axis. If a rotating tube is planned, it would be impossible to overcome the effects of gravity in all positions of the telescope if such balance were not achieved at the very beginning.

In most reflectors, the mirror and its cell are symmetrical about the optical axis, and diagonal supports are usually symmetrical also. But every instrument must have an eyepiece base mount, with the adapter tube and eyepiece itself, all represented by E in Fig. 1. If there is a finder, it will probably be mounted at least 45 degrees from the eyepiece, as shown by F. Obviously, these cause a tendency for the tube to rotate one way or the other, as shown in Fig. 1a and 1b; only in a special position, 1c, will E and F tend to balance each other. How can we obtain an equilibrium condition for all orientations of E and F with respect to the optical axis?

Our example will be the tube shown schematically in Fig. 2, with a diameter of 8″ and a three-pound finder whose center of gravity is 7″ from the optical axis. The two-pound eyepiece assembly has its center of gravity 5″ from the optical axis. As in Fig. 1, the angle EOF is 45°, and the direction of gravity is indicated by the arrow pointing downward just below the center O.

In order to compute the moments of force of E and F around O, we first assume a particular orientation of the tube. In this example, we take angle P′OE as 30°, which makes P′OF 75°, since angle EOF has been set at 45°. The construction lines of Fig. 2 show how to compute the moments, which act as if the weights of E and F were located at E′ and F′, on the horizontal line PP′. We shall denote the weights of E and F by E and F, respectively. The moment of E is E multiplied by the distance OE′, while that of F is F times OF′. The numerical results are shown in the diagram.

We will attempt to cure the rotational tendency by placing a counterweight W at a distance of 6″ from the optical axis, somewhere on the opposite side of the tube from E and F, as indicated by the

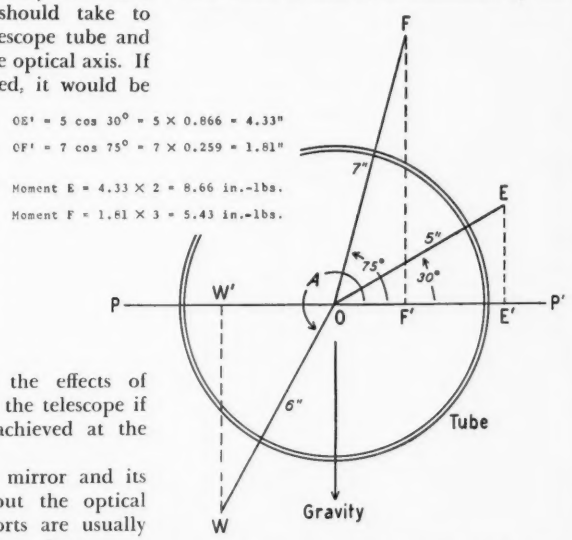

Fig. 2. In order to evaluate the angle A and to determine the amount of counterweight required, an arbitrary position of the tube is assumed. In Fig. 3, another position is chosen to permit setting up a second equation of equilibrium.

angle A. The moment of W is $6\,W \cos A$. Equilibrium requires that the sum of the moments of E, F, and W shall be zero:

$$8.66 + 5.43 + 6\,W \cos A = 0,$$

or

$$6\,W \cos A = -14.09. \quad (1)$$

But in this formula we have two unknowns, the weight W and the angle of orientation A. Therefore, in accordance with well-known algebraic rules, we need another independent equation, which can be derived by considering another position of the telescope tube.

Therefore, in Fig. 3 the whole system

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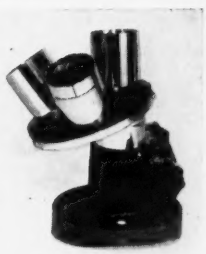

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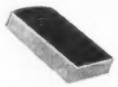

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has been rotated counterclockwise through 90°, placing E and F on the other side of the tube. A change of this kind commonly occurs when a rotating tube is used for ease in observing. In this position, the moments are different, the numerical values being given in the diagram. The equilibrium condition for Fig. 3 is:

$$-5.00 - 20.29 + 6\,W\,(-\sin A) = 0$$

or

$$6\,W \sin A = -25.29. \quad (2)$$

This condition is to be satisfied simultaneously with that of Equation 1. One method of solving these equations is to divide one by the other:

$$\frac{6\,W \sin A}{6\,W \cos A} = \tan A = \frac{-25.29}{-14.09} = 1.796.$$

Therefore A, which must be in the third quadrant since both its sine and cosine are negative, is 240°.9. Now we may substitute the cosine of A in Equation 1 and solve for W, which comes out to be 4.83 pounds.

As a check that in any position the tube will be in balance around the optical axis, the reader may wish to place the assembly in a new position and compute the moment of W against those of E and F. In some positions, however, W and E will be on one side of the tube and F on the other, and vice versa.

In actual practice, the weight W will be less than the calculated value, for it is necessary to take into account the weight of the supports that hold it to the tube. Furthermore, as far as equilibrium around the optical axis is concerned, W need not be at the top (eyepiece) end of a Newtonian reflector directly opposite E and F, although many amateurs prefer it there. It can be placed anywhere along the side of the tube on a line through W parallel to the optical axis. This permits using the counterweight to stabilize the tube around the declination axis, which is the next step in the balancing process.

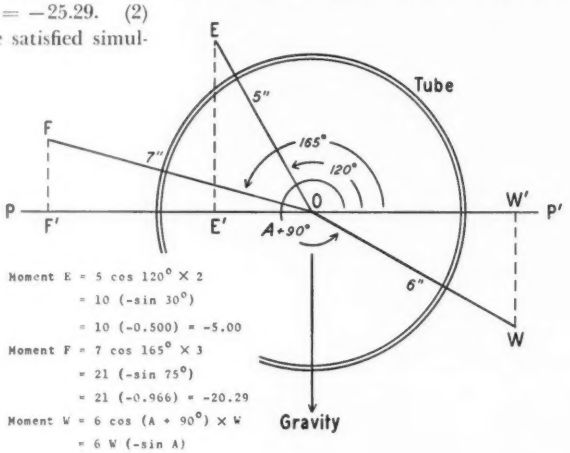
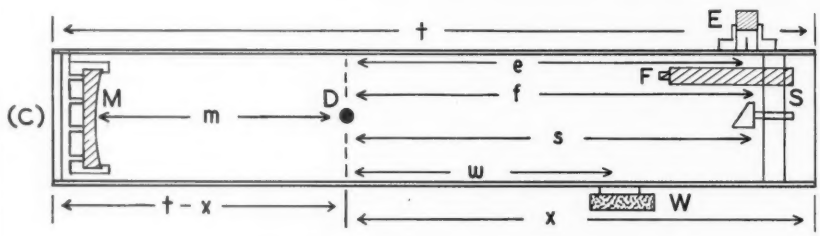


Fig. 3. Here the orientation of the tube has been changed 90 degrees in a counterclockwise direction, compared to the position in Fig. 2. Solving the equations of equilibrium based on these two situations gives the required angle A and the amount of counterweighting used.

Fig. 4 shows the general problem, in which the following components are indicated: eyepiece E, finder F, spider support and diagonal S, counterweight W, mirror and cell M, position of declination axis D. With respect to D, these parts are at the distances (along the optical axis) denoted by e for eyepiece, f for finder, and so forth. The over-all length of the tube is t, and the weight per unit length of the tube is T. The symbol x stands for the distance of D from the eyepiece end of the tube.

The condition for equilibrium is stated by the expression given in the diagram. The first moment is of the tube itself, for that part on the mirror side of D, where the weight is given by $T(t - x)$ and the distance by $\frac{1}{2}(t - x)$. For the other part of the tube, the moment is Tx



$$T\,(t-x)\,\tfrac{1}{2}\,(t-x) + Mm = Ee + Ff + Ss + Ww + \tfrac{1}{2}Tx^2$$

$$\text{or} \quad \tfrac{1}{2}Tt^2 - Ttx + Mm = Ee + Ff + Ss + Ww$$

Fig. 4. On the assumption that balance around the optical axis has first been achieved, the distances from the declination axis, D, to the various components may be measured as if they were located on the optical axis. For illustration purposes, the parts are pictured as if they were in the same plane. The basic formula for a condition of static balance around D is on the first line below the diagram; the second line gives a convenient working form of this formula.

times $\frac{1}{2}x$. The expression reduces to the form:

$$\tfrac{1}{2}Tt^2 - Ttx + Mm = Ee + Ff + Ss + Ww, \quad (3)$$

and from this general equation many arrangements may be computed, according to the needs of the telescope design.

A number of special cases are worth considering:

Case 1. Point D is centered at the midpoint of the telescope tube. Here $x = \frac{1}{2}t$, and $\frac{1}{2}Tt^2 - Ttx = 0$. Hence,

$$Mm = Ee + Ff + Ss + Ww. \quad (4)$$

If w comes out with a negative sign, the location of the counterweight is to the left of D, on the mirror end of the tube.

Case 2. The counterweight W is placed at the same distance from D as the eyepiece is. Equation 4 becomes

$$\tfrac{1}{2}Tt^2 - Ttx + Mm = e(E + W) + Ff + Ss. \quad (5)$$

If the mirror is relatively light, this construction will require a shift of the declination-axis position toward the eyepiece end of the tube.

Case 3. A combination of Case 1 and Case 2, in which D is at the tube's midpoint while W and E are at the same distance, e. In this case it is probable that an additional counterweight, C, will have to be added at the mirror end. As in Case 1, $x = \frac{1}{2}t$, and $\frac{1}{2}Tt^2 - Ttx = 0$. Therefore, we write

$$Cc + Mm = e(E + W) + Ff + Ss, \quad (6)$$

and the value of C will depend on the choice of the distance c between C and D.

Case 4. For a fork mounting, D may be placed one-third of the tube length from the mirror end. Here $x = \frac{2}{3}t$, and $\frac{1}{2}Tt^2 - Ttx = -\frac{1}{6}Tt^2$. Therefore

$$Mm - \tfrac{1}{6}Tt^2 = Ee + Ff + Ss + Ww. \quad (7)$$

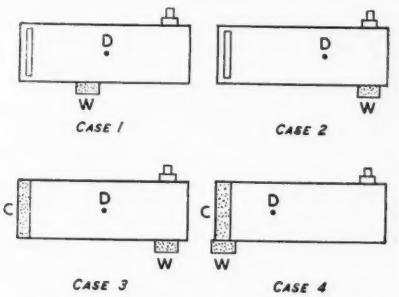


Fig. 5. The relative locations of D, W, and C in the four examples that are worked out in the text.

Numerical Examples

To illustrate the use of these formulas, let us adopt the following values: $M = 4$, $E = 2$, $F = 3$, $S = 1$, $W = 4.8$ lbs. $t = 48''$; $T = 0.15$ lb. per inch; $Tt = 7.2$. $m = t - x - 2$; $e = x - 4$; $f = x - 6$; $s = x - 3$.

Case 1. In this simple arrangement, with the declination axis in the center of the tube longitudinally, we can actually ignore the weight of the tube itself, as it

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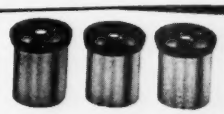

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is equally divided on each side of D. Since $x = 24$, Equation 4 becomes:

$$88 = 40 + 54 + 21 + 4.8w$$
$$w = -5.625.$$

The counterweight will have to be placed $5\frac{5}{8}$ inches from D toward the mirror end.

Case 2. Suppose it is desired to have W located approximately opposite the eyepiece at the upper end of the tube, making $w = e$. Where should the tube be supported? Using Equation 5, we have

$$172.8 - 7.2x + 184 - 4x = 10.8x - 48.2$$
$$x = 405/22 = 18.41,$$

which places D about 18½" from the eyepiece end of the tube and about 29½" from the mirror end.

Case 3. Since $x = 24$, Equation 6 gives

$$Cc + 88 = 259.2 - 48.2$$
$$Cc = 123.$$

This is the unbalanced moment at the mirror end, which could be compensated by a weight of over five pounds at the extreme end of the tube, 24 inches from D. However, a single weight would destroy the balance around the optical axis. To prevent this, we might divide the balancing weight in half, placing the halves diametrically opposite each other. Another way would be to fit a ring around the tube, making its weight six pounds and placing it about 16" from the centered position of D. Some amateurs prefer a weight under the mirror cell, where it can be symmetrically placed around the optical axis and where it requires the least weight because it is farthest from D.

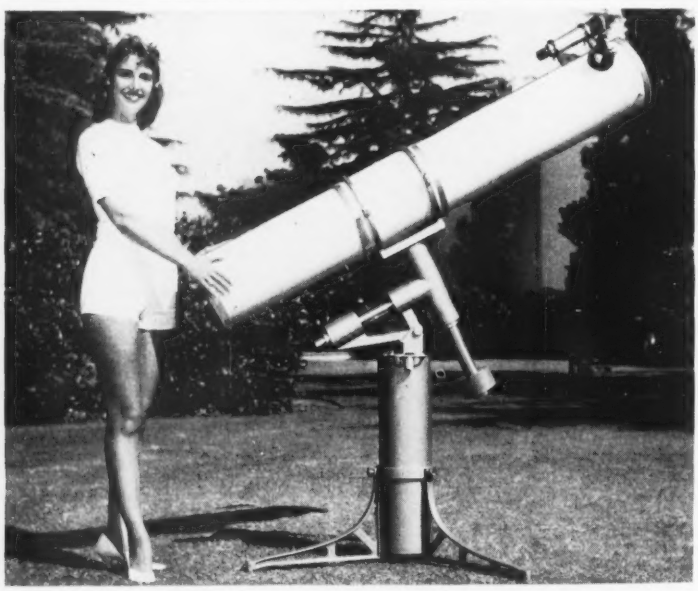
Case 4. For a fork-type mounting, the clearance of the mirror end in the fork determines the position of the declination axle. We have already assumed the support point to be two-thirds of the way from the upper (eyepiece) end. We use Equation 7 to find

$$56 - 57.6 = 56 + 78 + 29 + 4.8w$$
$$4.8w = -164.6$$
$$w = -34.3.$$

Counterweight W would have to be placed more than 34" to the left of D if it alone had to balance the tube. This position is obviously impossible, but if W were placed 16" from D, at the extreme mirror end of the tube, its moment would be only 76.8 inch-pounds. Another counterweight is necessary, and if it were at the extreme end, its weight would be about 5½ pounds, to furnish the additional moment of 87.8 inch-pounds. A better solution might be a ring counterweight, weighing about six pounds and placed 2" from the mirror end of the tube. In whatever way W and C are combined, they must provide a total moment of 164.6 inch-pounds. R. E. C.

CORRECTION

On page 652 of the October issue, in the ninth line of the middle column, for 1½" read 1¼".



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7 x 50	372	"Zeiss"	**24.95**	**22.50**
7 x 50	372	American	**32.50**	—
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ERFLE EYEPIECE (65° field) contains 3 coated achromats. 1½" E.F.L., clear aperture 2⅛". Has a focusing mount with diopter scale. Will make an excellent 35-mm. Kodachrome Viewer. Magnifies seven times ..... **$12.50 ppd.**

Same as above without diopter scale **$9.95**

WIDE ANGLE ERFLE (68° Field) **EYEPIECE.** Brand new; coated 1¼" E.F.L. Focusing mount. 3 perfect achromats, 1-13/16" aperture **$13.50**

WIDE ANGLE ERFLE 1½" E.F.L. Brand new; contains Eastman Kodak's rare-earth glasses; aperture 2"; focusing mounts; 65° field **$12.50**

1¼" Diam. Adapter for Erfle eyepieces **$3.95**

SPECIAL COATED OBJECTIVE BIG 2⅛" DIAM. — 40" F.L. — $6.00

These achromatic objective lenses are tested and have the same high quality as "Big Lenses" described at left, except they are seconds for slight edge chips or small scratches only. Quality guaranteed.

ONLY $6.00 ppd.

ASTRONOMICAL MIRRORS

These mirrors are of the highest quality, polished to ¼-wave accuracy. They are aluminized, and have a silicon-monoxide protective coating. You will be pleased with their performance.

	Diam.	F.L.	Postpaid
Plate Glass	3-3/16"	42"	**$ 9.75**
Pyrex	4¼"	45"	**13.50**
Pyrex	6"	60"	**25.00**

MIRROR MOUNTS, RACK-AND-PINION ● EYEPIECE MOUNTS, and ALUMINUM TUBING are available.

90° RIGHT-ANGLE PRISMS

8-mm. face	**$1.00**	———	
12-mm. face	**1.00**	———	
23-mm. face	**1.25**	Silvered	**$2.00**
28-mm. face	**1.75**	Silvered	**2.50**
38-mm. face	**2.00**	Silvered	**2.75**
48-mm. face	**3.00**	Silvered	**4.00**

62-mm. face, coated **$17.50**

TELEVISION PROJECTION LENS

Brand New, f/1.9, E.F.L. 5 inches. Manufactured by Bausch & Lomb. We purchased entire lot of these discontinued units. Five elements, smallest lens 2", largest 4⅛". Completely assembled 6" in length. All surfaces hard coated. Get this BARGAIN now.

ONLY $22.50

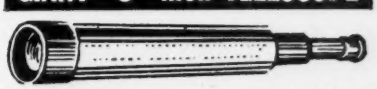
MOUNTED EYEPIECES

The buy of a lifetime at a great saving. Perfect war-surplus lenses set in black-anodized standard aluminum 1¼" O.D. mounts.

F.L.	TYPE	PRICE
6 mm. (¼")	Ramsden	**$ 4.75**
12.5 mm. (½")	Ramsden	**4.50**
12.5 mm. (½")	Symmetrical	**6.00**
16 mm. (⅝")	Erfle (wide angle)	**12.50**
16 mm. (⅝")	Triplet	**12.50**
18 mm. (¾")	Symmetrical	**6.00**
22 mm. (27/32")	Kellner	**6.00**
27 mm. (1-1/16")	Kellner	**4.50**
32 mm. (1¼")	Orthoscopic	**12.50**
35 mm. (1⅜")	Symmetrical	**8.00**
55 mm. (2-3/16")	Kellner	**6.00**
56 mm. (2¼")	Symmetrical	**6.00**

COATED LENSES 75 cents extra.

GIANT "3" inch TELESCOPE



40 POWER **postpaid $57.50**

HIGH-POWER SPOTTING SCOPE — American Made. Big 3"-diameter achromatic coated objective will give bright crystal-clear images. Micrometer spiral focusing drawtube. Lightweight aluminum construction throughout, black crackle finish, length open 22", closed 15½". Upright image. Guaranteed to give superb performance.

8-POWER ELBOW TELESCOPE

8 x 50

This M-17 telescope has a brilliant-image 48° apparent field — 325 feet at 1,000 yards. The telescope can be adjusted for focusing 15 feet to infinity. It has a 2" objective, focusing eyepiece 28-mm. focal length with an Amici erecting system. Turret-mounted filters: clear, red, amber, and neutral. Lamp housing to illuminate reticle for nighttime use. Truly the biggest bargain you were ever offered. Original Gov't. cost $200.

BARGAIN PRICE .... **$13.50 ppd.**

A. JAEGERS

6918 Merrick Road LYNBROOK, N. Y.

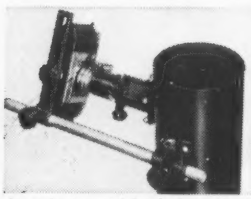
JUST REDUCED!

SATELLITE TELESCOPE

In setting the original price of our Satellite Telescope we figured amortization of tooling and engineering over 1,000 scopes. While sales haven't reached this point, because so many made their own instruments by using our unmounted optics, we have decided to take our loss on tool amortization and reduce the price. It's still the best satellite telescope available, so get yours now! Especially made for members of MOON-WATCH. Gives you the greatest possible field with the ability to observe faint objects with only slight magnification. Wide (51-mm.) diameter, low-reflection-coated objective lens. A 6-element, extremely wide field, coated Erfle eyepiece, which in combination with the objective gives 5.5 power with a big 12° field and over 7-mm. exit pupil. This scope also makes a perfect wide-field finder — a wonderful comet seeker; see complete asterisms with it.

Stock #70,074-Y.....$39.50 ppd.

Take Photos of the MOON Through Your Telescope with the EDMUND CAMERA HOLDER for TELESCOPES



Bracket attaches permanently to your reflecting or refracting telescope. Removable rod with adjustable bracket holds your camera over scope's eyepiece and you're ready to take exciting pictures of the moon. You can also take terrestrial telephoto shots of distant objects. Opens up new fields of picture taking!

SUN PROJECTION SCREEN INCLUDED

White metal screen is easily attached to holder and placed behind eyepiece. Point scope at sun, move screen to focus . . . and you can see sunspots!

All for the low, low price of $9.95

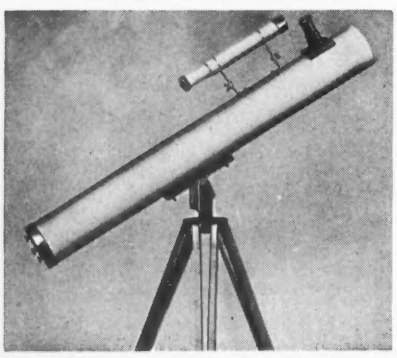
Includes brackets, 28¾" rod, projection screen, screws, and directions. Aluminum . . . brackets black crinkle painted.

Stock #70,162-Y.....$9.95 ppd.

Send check or money order — Money-back guarantee.

3" ASTRONOMICAL REFLECTOR

60 to 160 Power — An Unusual Buy!

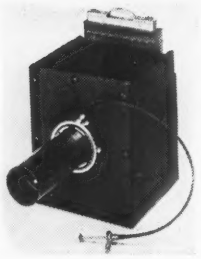


Assembled — ready to use! See Saturn's rings, the planet Mars, huge craters on the moon, star clusters, moons of Jupiter, double stars, nebulae, and galaxies! Equatorial-type mounting with locks on both axes. Aluminized and over-coated 3"-diameter f/10 primary mirror, ventilated cell. Telescope comes equipped with a 60X eyepiece and a mounted Barlow lens, giving you 60 to 160 power. A finder telescope, always so essential, included. Sturdy, hardwood, portable tripod.

Free with scope: Valuable STAR CHART and 272-page ASTRONOMY BOOK.

Stock #85,050-Y.....$29.95 ppd.

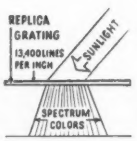
TELESCOPE CAMERA



Here is a special camera for taking excellent closeup shots through your telescope — pictures of the moon, stars . . . terrestrial telephoto pictures. Sturdily built, easily operated, this useful camera employs sheet film. One film holder, size 2¼" x 3¼", is included. Camera lens is 4-element — not only magnifies the image but extends it from normal eyepiece image plane to film plane. Yellow filter included. Camera box size is 3" x 4" x 5". Tube that fits into eyepiece holder is 5" long with 1¼" O.D. for standard telescopes. Cable release and 3¼"-x-4½" piece of ground glass for focusing also included. Precision German-made shutter has settings for Time, Bulb, 1, ½, 1/5, 1/10, 1/25, 1/100, and 1/200 second. Also has delayed-action shutter release.

Stock #70,166-Y.....$39.50 ppd.

REPLICA GRATING Low, Low Cost

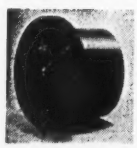


It's here — after decades of effort! Replica grating — on film — at very low price. Breaks up white light into full spectrum colors. An exciting display. 13,400 lines per inch, running long way on film 8" wide — grating area 7½". Thickness about 0.005". Dispersion about 24° in 1st order. Use it for making spectroscopes, for experiments, as a fascinating novelty. First time available in such a large size — so cheaply. Comes in clear-plastic protector.

Stock #40,267-Y....8" by 11" piece.....$1.50 ppd.
Stock #50,180-Y....8" by 6' piece.....$5.95 ppd.

Mounted Ramsden Eyepieces

Standard 1¼" Diameter



Our economy model, standard-size (1¼" O.D.) eyepiece. We mounted two excellent quality plano-convex lenses in black anodized aluminum barrels instead of chrome-plated brass to save you money. The clear image you get with these will surprise you. Directions for using short focal length eyepieces are included with both the ¼" and ½" models.

Stock #30,204-Y....¼" focal length....$4.75 ppd.
Stock #30,203-Y....½" focal length....$4.50 ppd.

OBSERVE SUNSPOTS

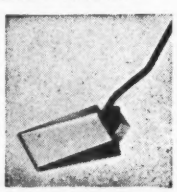
Reduce intensity of the sun's rays, by using a Herschel wedge plus a sun filter over the eyepiece.

UNMOUNTED HERSCHEL WEDGE

Size, 40 mm. x 55 mm.; wedge angle is 10°. The critical surface is flat to ¼ wave. Not mounted.

Stock #30,265-Y.....$3.50

MOUNTED HERSCHEL WEDGE



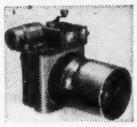
Same size as above but mounted with diagonal holder for reflectors. Fits our rack-and-pinion holder, Stock No. 50,077-Y, that is also used on our 4¼" and 6" reflectors. Holder rod is long enough for 4¼", 6", and 8" mirrors. Rod is 5/32" diameter and 5" long.

Stock #30,266-Y....$5.50

INVITATION

VISIT OUR RETAIL STORE — (10 miles from Philadelphia — two miles from Exit #3 of the New Jersey Turnpike). When you're near us, stop in and see our big display. Our store contains many miscellaneous items at bargain prices.

K-24 AERIAL CAMERA



War surplus. New or near new — guaranteed perfect working order. Excellent camera for photographing satellites. Complete with 7" f/2.5 Kodak Aero Ektar lens and magazine which takes film 5½" wide x 26' long.

Stock #85,067-Y.....$99.50 f.o.b. Utah

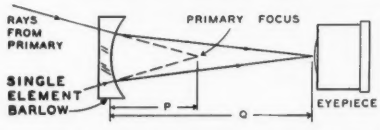
AERIAL CAMERA LENS

f/2.5 with 7" Focal Length

An excellent lens — can be adapted for use on 35-mm. and Speed Graphic cameras as a telephoto lens. Three of the first four pictures of Sputnik III were taken by a student with a homemade camera using one of these lenses. Adjustable diaphragm, f/16 to f/2.5. Gov't. cost over $400. War surplus.

Stock #70,161-Y.....$39.95 ppd.

DOUBLE AND TRIPLE YOUR TELESCOPE'S POWER WITH A BARLOW LENS



WHAT IS A BARLOW? A Barlow lens is a negative lens used to increase the power of a telescope without resorting to short focal length eyepieces, and without the need for long, cumbersome telescope tubes. Referring to the diagram above, a Barlow is placed the distance P inside the primary focus of the mirror or objective. The Barlow diverges the beam to a distance Q. This focus is observed with the eyepiece in the usual manner. Thus, a Barlow may be mounted in the same tube that holds the eyepiece, making it very easy to achieve the extra power. The new power of the telescope is not, as you might suppose, due to the extra focal length given the objective by the difference between P and Q. It is defined as the original power of the telescope times the quotient of P divided into Q.

Beautiful chrome mount. We now have our Barlow lens mounted in chrome-plated brass tubing with special spacer rings that enable you to vary easily the power by sliding split rings out one end and placing them in other end. Comes to you ready to use. Just slide our mounted lens into your 1¼" I.D. tubing, then slide your 1¼" O.D. eyepieces into our chrome-plated tubing. Two pieces provided, one for regular focal length eyepieces and one for short focal length ones.

Remember, in addition to doubling and tripling your power, a Barlow lens increases your eye relief and makes using a short focal length eyepiece easier.

Don't fail to try one of these. Many people do not realize the many advantages of a Barlow and the much greater use they can get from their telescopes. Our Barlow has a focal length of −1-5/16". We have received many complimentary letters about this lens. So sure are we that you will like it that we sell it under a 30-day guarantee of satisfaction or your full purchase price returned — no questions asked. You can't lose, so order today.

Stock #30,200-Y Mounted Barlow lens.....$8.00 ppd.

WAR-SURPLUS TELESCOPE EYEPIECE

Mounted Kellner Eyepiece, Type 3. 2 achromats, focal length 28 mm., eye relief 22 mm. An extension added, O.D. 1¼", standard for most types of telescopes. Gov't. cost $26.50.

Stock #5223-Y.....$7.95 ppd.

EDMUND SCIENTIFIC CO.

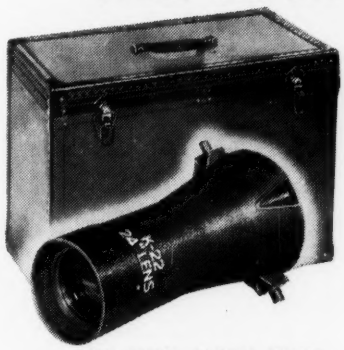
Sale! Terrific Bargains!

WAR-SURPLUS AERIAL CAMERA LENSES

24" Focal Length, f/6, in 23"-long Lens Cone

Made by Bausch & Lomb and Eastman Kodak

$39.50, Used; $59.50, New; Gov't. Cost $1,218.00



Mounted in beautiful brass cells, lenses are 4"-diameter precision 4-element type. Aero Tessar and Aero Ektar (no choice). Housed in cone — focal plane 10" beyond cone and permits attaching a film holder, eyepiece, or the like. Lenses are easily removed for other uses. Diaphragm is included — adjusts by flexible rod (easily extended) from f/6 to f/22; opens approximately 1" to 3½". Weight of lens and cone 25 lbs. Sturdy carrying trunk weighs 26 lbs.

USES: 1. For use as long-range, Big Bertha telephoto lens. 2. For richest field (wide field, low power) telescope. 3. As opaque projector lens. 4. For use in operation PHOTOTRACK (photographing artificial satellites).

SALE AERIAL CAMERA LENSES

Lens Cones with f/6 24" focal length —

Stock #85,059-Y....24", Used.....$39.50 f.o.b. Utah

Stock #85,060-Y....24", New.....$59.50 f.o.b. Utah

ALSO AVAILABLE

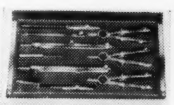
Lens Cones with f/8 40" focal length —

Stock #85,061-Y.....Used.....$68.50 f.o.b. Utah

Stock #85,062-Y.....New.....$89.50 f.o.b. Utah

TRULY AMAZING BARGAIN — MECHANICAL DRAWING SET

Regular Price, $18.00 — Our Price, Only $6.00 ppd.

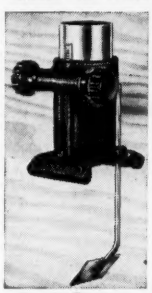


10 handsome pieces in velvet-lined case. Bows have center wheels; dividers are 5½" long. Instruments are nickel-plated brass, precision American made. Set contains 5½" Swedish ruling pen, 5½" compass, lengthening bar for compass 3¾", interchangeable pen for compass, 5½" dividers with straightening device, center-wheel 3" bow pen, center-wheel 3" bow pencil, center-wheel 3" bow divider, adjusting screwdriver, spare-parts container with leads and points. We guarantee you will be satisfied or your money refunded.

Stock #50,200-Y.....$6.00 ppd.

Quantity prices: 5 sets for $5.50 each ppd.
10 sets for $5.00 each ppd.

Rack & Pinion Eyepiece Mounts



Real rack-and-pinion focusing with variable tension adjustment: tube accommodates standard 1¼" eyepieces and accessory equipment; lightweight aluminum body casting (not cast iron); focusing tube and rack of chrome-plated brass; body finished in black wrinkle paint. No. 50.077-Y is for reflecting telescopes, has focus travel of over 2", and is made to fit any diameter or type tubing by attaching through small holes in the base. Nos. 50.103-Y and 50.108-Y are for refractors and have focus travel of over 4". Will fit our 2⅞" I.D. and our 3⅞" I.D. aluminum tubes respectively.

For Reflectors

Stock #50,077-Y (less diagonal holder) $8.50 ppd.
Stock #60,049-Y (diagonal holder only) 1.00 ppd.
Stock #50,103-Y (for 2⅞" I.D. tubing) 12.95 ppd.
Stock #50,108-Y (for 3⅞" I.D. tubing) 13.95 ppd.

5" DIAM. TELESCOPE OBJECTIVE AIR-SPACED ACHROMAT

Coated 4 surfaces. Focal length 71". f/14.2. Effective aperture f/15, 4.73".

Stock #70,163-Y...Unmounted.....$125.00 ppd.

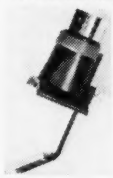
Stock #70,164-Y...Mounted in cell (Inside diam. 5"; outside diam. 5½" with 6½" flange) with adapter to fit 6⅞" I.D. tubing.....$150.00 ppd.

"MAKE-YOUR-OWN" 4¼" MIRROR KIT

The same fine mirror as used in our telescopes, polished and aluminized, lenses for eyepieces, and diagonal. No metal parts.

Stock #50,074-Y.....$16.25 ppd.

STANDARD 1¼" EYEPIECE HOLDER



Here is an economical plastic slide-focus eyepiece holder for 1¼" O.D. eyepieces. Unit includes 3"-long chrome-plated tube into which your eyepiece fits for focusing. Diagonal holder in illustration is extra and is not included.

Stock #60,067-Y.....$2.50 ppd.

PRISM STAR DIAGONAL

For comfortable viewing of the stars near the zenith or high overhead with refracting telescopes using standard size (1¼" O.D.) eyepieces, or you can make an adapter for substandard refractors. Contains an excellent quality aluminized right-angle prism. Tubes are satin chrome-plated brass. Body is black wrinkle cast aluminum. Optical path of the system is about 3½".

Stock #70,077-Y.....$12.00 ppd.

"TIME IN ASTRONOMY" BOOKLET

By Sam Brown. All about various kinds of time, contains sidereal timetable. How to use single- and double-index setting circles, how to adjust an equatorial mount, list of sky objects. Also includes 7" paper setting circles and stripes suitable for cutting out and mounting on plywood. Wonderfully illustrated.

Stock #9054-Y.....60c ppd.

OTHER USEFUL BOOKLETS

"OBSERVING THE SUN"
Stock #9056-Y.....15c ppd.

"TELESCOPE FINDERS"
Stock #9051-Y.....15c ppd.

Sale! GIANT ERFLE EYEPIECE

Here is an exciting bargain. We just bought a large lot of these eyepieces reasonably — so down goes the price to $9.95 for a real sale. Lens system contains 3 coated achromats over 2" in diameter. Gov't. cost over $100.00. Brand new, weight 2 pounds. The value will double when this sale is over, and triple and quadruple as years pass. If we didn't owe the bank so much money, we'd be tempted to hold onto these eyepieces. Their wide apparent field is 65°. The focal length is 1½". Lenses are in a metal cell with spiral threads; focusing adapter with 32 threads per inch is included; diameter is 2-11/16". If you don't order now and you miss out on a hundred-dollar eyepiece for only $9.95, you can't say that we didn't try to impress you with its value. You can make some super-duper finders with these eyepieces. They are also ideal for rich-field telescopes, which are becoming more popular daily, particularly in the Sputnik age. Everyone with a large reflecting telescope should have one of these.

Stock #50,178-Y.....Sale Price $9.95 ppd.

3X ELBOW TELESCOPE

Sometimes the war-surplus end of this business is heartbreaking. Here is an excellent little telescope that cost Uncle Sam about $200.00. Makes a dandy finder with a 13° field. Weight 2 pounds, size 5¾" x 4½". Although our price has been only $7.50 postpaid, they just sit on our shelves year after year. Then to get an item we really wanted, we had to buy 200 more of these telescopes recently. Objective lens is an achromat, diameter 26 mm., focal length 104 mm. Amici roof prism with faces of 18 mm. x 20 mm. cost from $12.00 to $36.00 to make. Symmetrical eyepiece of 1¼" (32.5 mm.) effective focal length consists of 2 achromats with diameters of 34 mm. and focal lengths of 65 mm. At our new price we cannot afford to have our instrument man take these apart and clean them — so we told him to look them over to make sure everything is okay, and now you can buy them for only $5.00 each delivered to you.

Stock #50,179-Y.....$5.00 ppd.

6X FINDER TELESCOPE

Has crosshairs for exact locating. You focus by sliding objective mount in and out. Base fits any diameter tube — an important advantage. Has 3 centering screws for aligning with main telescope. 20-mm.-diameter objective. Weighs less than ½ pound.

Stock #50,121-Y.....$8.00 ppd.

MIRROR STAR DIAGONAL

For comfortably viewing astronomical objects with refracting telescopes — also excellent for finders on reflecting telescopes. Can be used on standard microscopes as it is correct size. Eyepiece end takes oculars with 0.917" O.D. and objective end fits into tubes with 0.917" I.D. Made of fine plastic, and contains a first-surface mirror.

Stock #30,278-Y.....$3.00 ppd.

7X FINDER TELESCOPE—ACHROMATIC

Stock #50,080-Y Finder alone, less ring mounts...$9.95

Stock #50,075-Y Ring mounts per pair.....$3.95

BE SURE TO GET FREE CATALOG "Y"

Fantastic variety — never before have so many lenses, prisms, optical instruments, and components been offered from one source. Positively the greatest assembly of bargains in all America. Imported! War Surplus! Hundreds of other hard-to-get optical items. Write for Free Catalog "Y."

ORDER BY STOCK NUMBER . . . SEND CHECK OR MONEY ORDER . . . SATISFACTION GUARANTEED!

BARRINGTON • NEW JERSEY

Satellite Observers

Here is an extremely fine, imported Zuiho binocular, just the thing for satellite observing. Note the wide field of view — 10.5°!

Delivered anywhere in the Continental United States.

Complete with beautiful case **$35.00** TAX PAID

AMERICAN TYPE WIDE ANGLE
7 x 35 Central Focus

SPECIFICATIONS —

Magnification	7x
Objective aperture	35 mm.
Eyepiece aperture	24 mm.
Diameter of exit pupil	5 mm.
Field of view at 1,000 yards	551 feet
Field-of-view angle	10.5°
Height	128 mm.
Breadth	195 mm.
Net weight	950 grams
Weight of pigskin case	400 grams

We have sold hundreds of pairs of these binoculars with the utmost satisfaction. Remember, they are unconditionally guaranteed. If you are not pleased with them, send them back to us and your money will be immediately refunded.

Before you buy or trade a telescope or radio amateur gear, see WARD W2FEU for the best deal.

ADIRONDACK RADIO SUPPLY

Established 1936
P. O. BOX 88
AMSTERDAM, NEW YORK
Ward J. Hinkle, W2FEU — Owner

CELESTIAL CALENDAR

Universal time (UT) is used unless otherwise noted.

VARIABLE STAR MAXIMA

November 1, S Ursae Majoris, 123961, 7.9; 7, R Virginis, 123307, 6.9; 9, R Phoenicis, 235150, 7.8; 17, T Columbae, 051533, 7.6; 18, S Canis Minoris, 072708, 7.5; 22, T Cassiopeiae, 001755, 7.8; 30, R Leonis Minoris, 093934, 7.2; 30, V Bootis, 142539, 7.9.

December 7, T Centauri, 133633, 6.1; 16, T Herculis, 180531, 8.0; 20, R Ursae Majoris, 103769, 7.6.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

NOVEMBER METEORS

Two weak meteor showers are observable this month, neither of which will be seriously masked by moonlight. The Taurids reach maximum during the first seven days of November, when a single observer may see up to 12 meteors per hour, including sporadic ones. The Leonids come during the morning hours of November 16-17. If sky conditions are favorable, 15 to 20 meteors per hour may be visible before dawn, according to P. M. Millman, but a much lower hourly rate is cited by H. B. Ridley in the 1958 *Handbook* of the British Astronomical Association. W. H. G.

MINOR PLANET PREDICTIONS

Amphitrite, 29, 8.7. October 24, 3:36.5 +27-18. November 3, 3:27.8 +27-24; 13, 3:17.4 +27-13; 23, 3:06.8 +26-48. December 3, 2:57.5 +26-14; 13, 2:50.7 +25-38. Opposition on November 14.

Flora, 8, 7.9. October 24, 4:02.1 +9-45. November 3, 3:55.4 +9-21; 13, 3:46.0 +9-05; 23, 3:35.5 +9-03. December 3, 3:25.9 +9-18; 13, 3:18.8 +9-53. Opposition on November 19.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1950.0) for 0^h Universal time. In each case the motion of the asteroid is retrograde. Data are supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

MINIMA OF ALGOL

November 1, 13:39; 4, 10:27; 7, 7:16; 10, 4:05; 13, 0:54; 15, 21:43; 18, 18:32; 21, 15:21; 24, 12:10; 27, 8:59; 30, 5:48.

December 3, 2:37; 5, 23:26; 8, 20:15.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Krakow Observatory. The times given are geocentric; they can be compared directly with observed times of least brightness.

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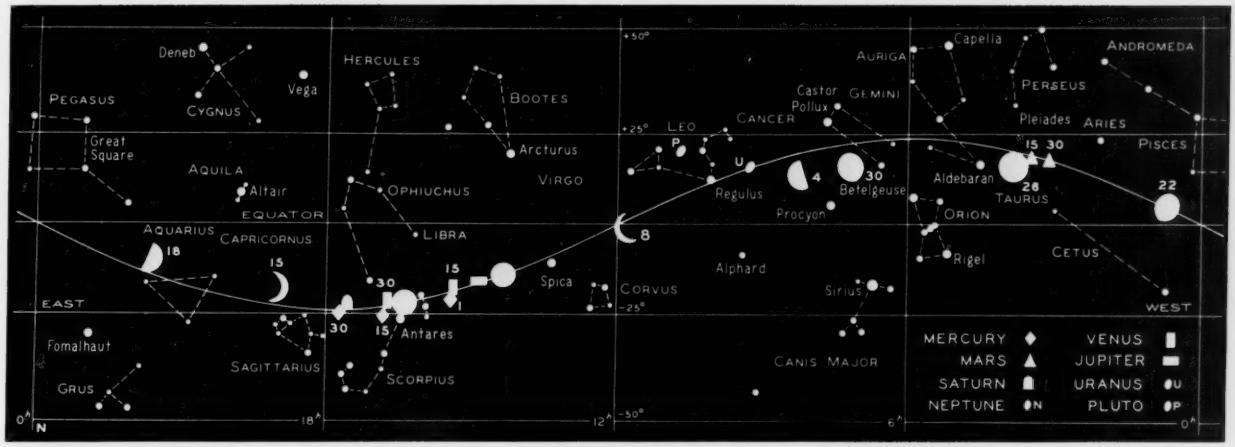

THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month or for other dates shown. All positions are for 0^h Universal time on the respective dates.

Mercury is an evening star throughout November, reaching greatest eastern elongation on the 20th, 22° 13′ from the sun. This is not a favorable elongation, but during the last half of November the planet may be seen during early twilight, low in the southwest and of magnitude −0.1, setting an hour after the sun.

Venus reaches superior conjunction with the sun on the 11th, passing from the morning to the evening sky, but all month it will be too close to the sun to be seen.

Mars is the dominating planet in the nighttime sky, well situated at a high northerly declination in western Taurus, where it rises about sunset and remains visible all night. This is the month of opposition, which occurs on November 16th, but closest approach to the earth occurs on the 8th, when Mars will be only 45.4 million miles distant. Telescopically, the planet will appear as a reddish disk 19″ in diameter.

Mars' magnitude is −1.8 on November 1st, −2.0 on the 15th, and −1.6 on the 30th; the planet will be roughly 10 times as bright as nearby Aldebaran, a reddish star of the 1st magnitude. The moon and Mars will make a fine sight during the night of November 24-25, when the moon passes about 3° south of the planet.

Jupiter is in conjunction with the sun on November 5th, and lost in its glare.

Saturn can be seen low in the southwest on the Ophiuchus-Sagittarius border, setting about two hours after the sun in the middle of the month.

Uranus will reach western quadrature on November 9th, rising slightly before midnight. On the 15th its apparent right ascension is 9^h 16^m.0, declination +16° 35′. On the 22nd, this 6th-magnitude planet will be stationary in right ascension, beginning its slow retrograde (westerly) motion among the stars.

Neptune is an 8th-magnitude object in Virgo west of Jupiter, and not observable this month.

Artificial satellite observations in November may be made with the help of a star chart from an October issue for evening twilight, from an April issue for morning. W. H. G.

MOON PHASES AND DISTANCE

Last quarter	November	4, 14:19
New moon	November	11, 6:34
First quarter	November	18, 4:59
Full moon	November	26, 10:16
Last quarter	December	4, 1:24

	November	**Distance**	**Diameter**
Perigee	10, 14^h	222,300 mi.	33′ 24″
Apogee	23, 5^h	252,200 mi.	29′ 27″
	December		
Perigee	9, 0^h	224,600 mi.	33′ 04″

UNIVERSAL TIME (UT)

TIMES used in Celestial Calendar are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, in which case the result is your standard time on the day preceding the Greenwich date shown.

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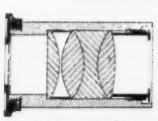

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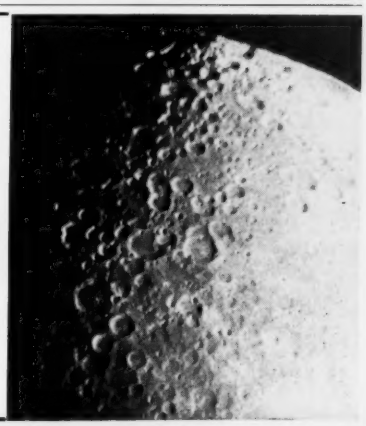

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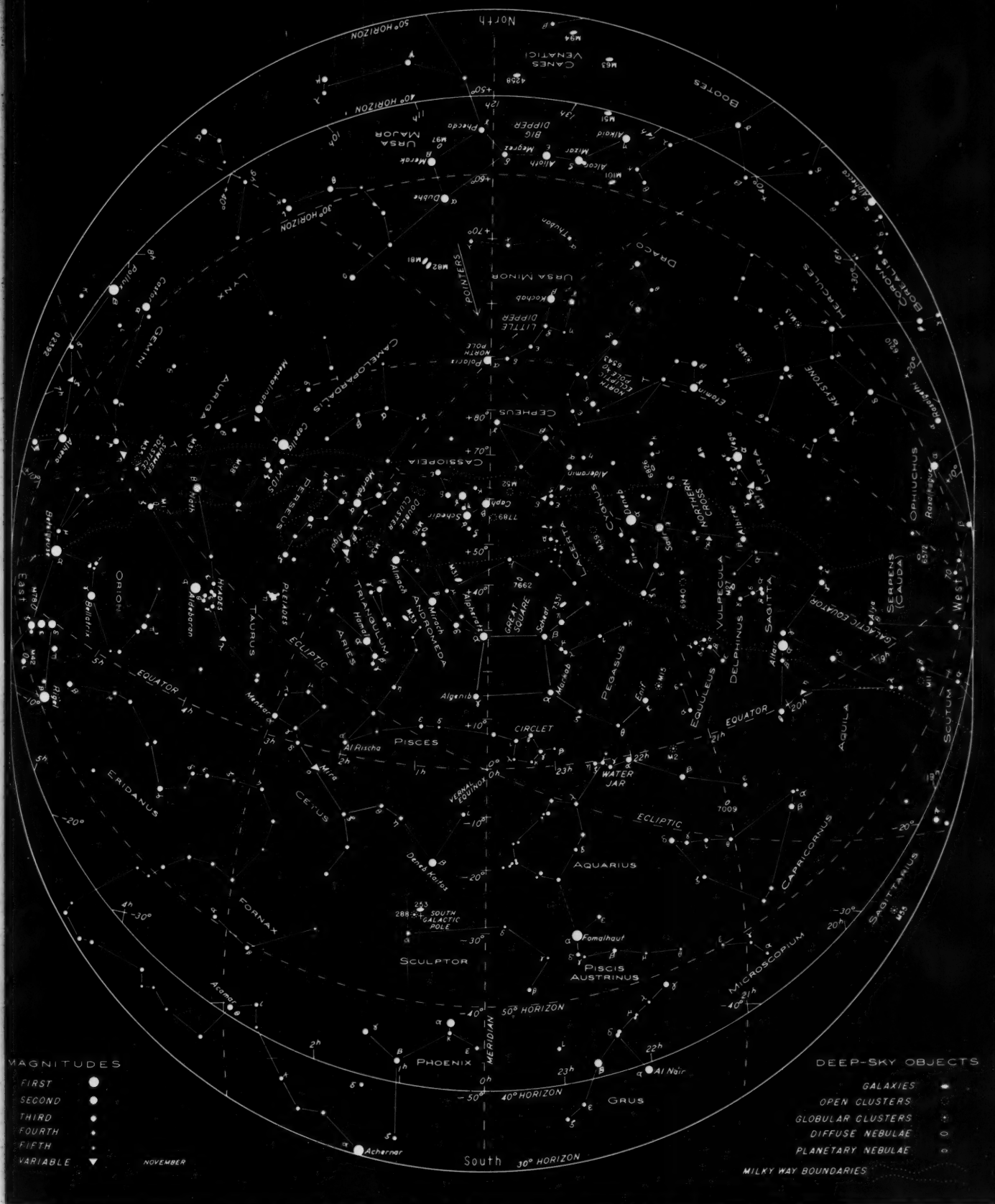

STARS FOR NOVEMBER

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of November, respectively; also, at 7 p.m. and 6 p.m. on December 7th and 23rd. For other dates, add or subtract ½ hour per week.

The eastern side of the Great Square of Pegasus, near the meridian now, points southward toward Deneb Kaitos, in Cetus. Much farther south is bright Achernar, just above the horizon for observers at latitude 30° north. The western side of the Great Square points to Fomalhaut.

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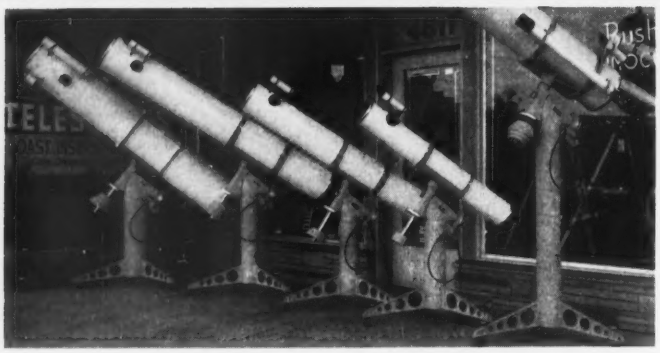

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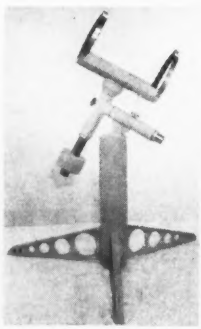

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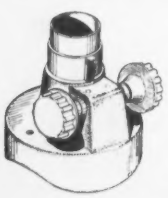

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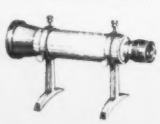

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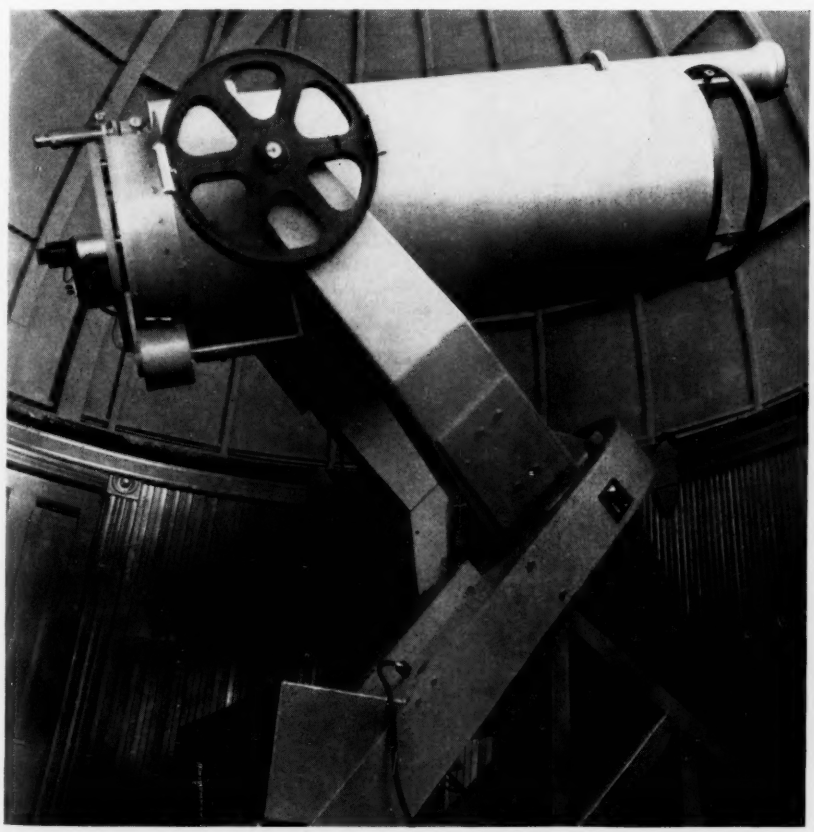

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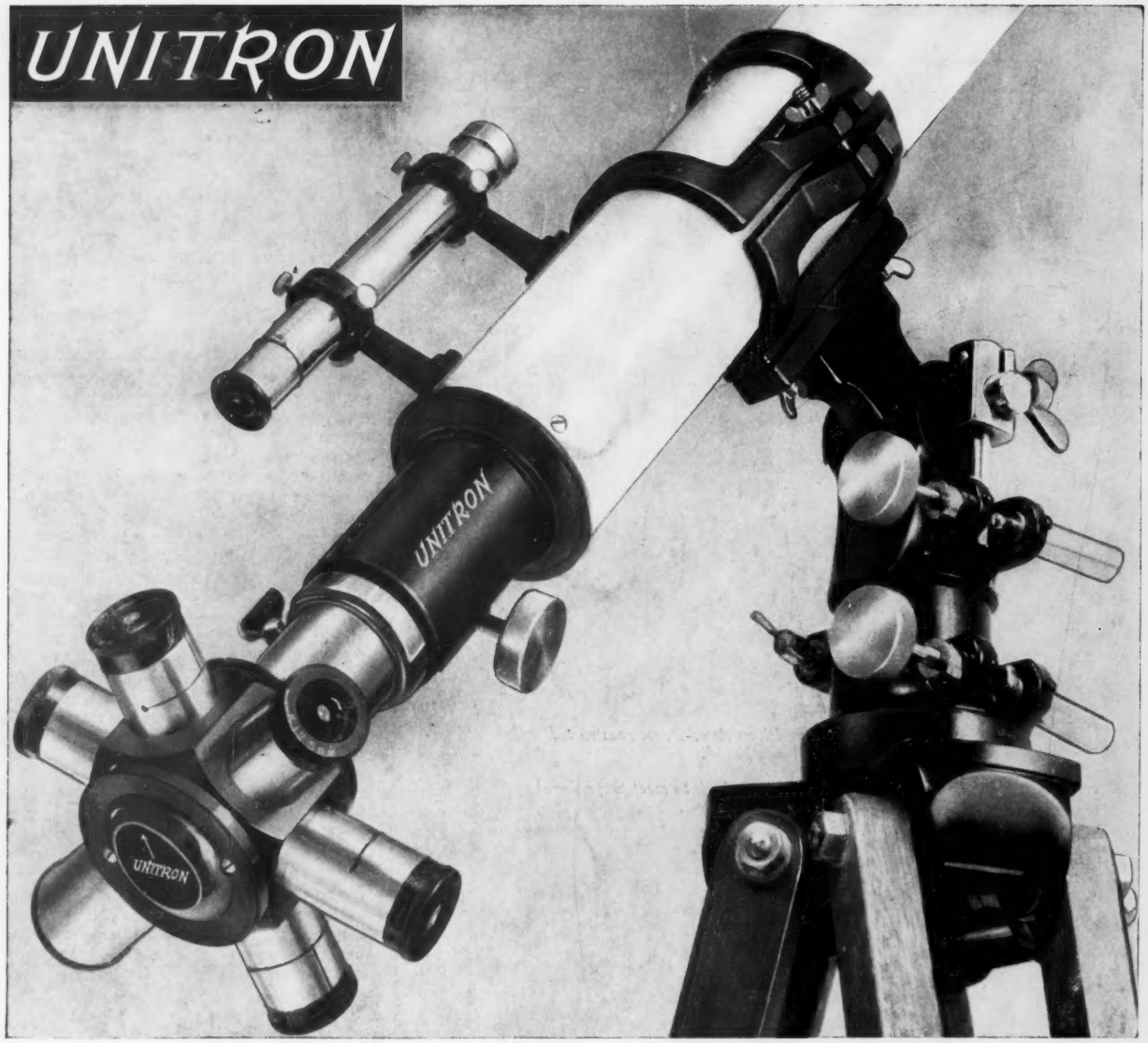

It takes only $12.50 down to own this UNITRON

Little wonder that the UNITRON 2.4" Altazimuth Refractor has long been America's most popular low-priced refractor.

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See pages 32 and 33.

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